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PROMOTING ECOLITERACY AND ECOSYSTEM MANAGEMENT FOR
SUSTAINABILITY THROUGH ECOLOGICAL ECONOMIC TOOLS

A Dissertation Presented

by

Valerie Esposito

to

The Faculty of the Graduate College

of

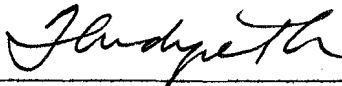
The University of Vermont

In Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
Specializing in Natural Resources and Ecological Economics

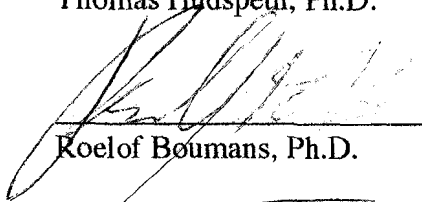
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Accepted by the Faculty of the Graduate College, The University of Vermont, in partial fulfillment of the requirements for the degree of Doctor of Philosophy, specializing in Natural Resources and Ecological Economics.

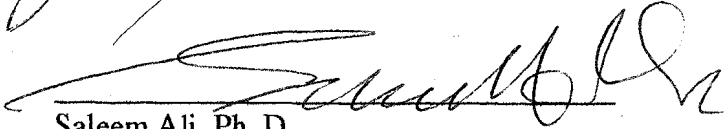
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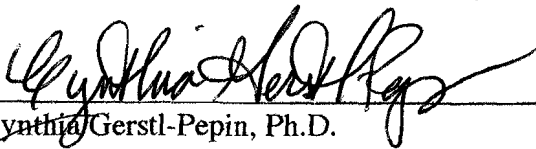
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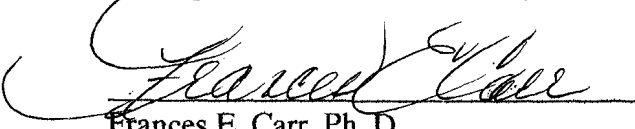
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ABSTRACT

The importance and contribution of healthy ecosystems to human well-being and poverty reduction have gained increasing awareness and attention in recent years. Despite this wide-scale acknowledgement, the majority of the benefits yielded by ecosystem services are currently exogenous to the economic system, so their value is not equally weighted in decisions that directly impact their functioning and welfare. Public understanding of the importance of these contributions and the necessity of healthy ecosystems and sound management is vital for their conservation. However, thorough understanding of what ecosystems are, how they function, and how to manage them on a systems-based level for sustainability, known as ecological literacy (ecoliteracy), is lacking in various publics. In fact, at the nexus of the complex environmental problems facing the world today is the lack of understanding of the impact of individual and aggregate actions, particularly on ecosystems.

The emerging field of ecological economics seeks to reconcile the roots for this disconnect. By developing new methods of ecosystem management that simultaneously address complex economic, social and environmental needs, ecological economics seeks to develop a comprehensive, systems-based approach to engender global sustainability. Ecoliteracy is a critical component to developing new methods in development and management. This dissertation research examines and applies several ecological economic tools – rapid assessment valuation, payments for ecosystem services and service-learning education – to determine how to best promote ecoliteracy and ecosystem management on individual and collective levels.

There are several findings that highlight the importance of and areas of improvement for integrating such tools in a comprehensive sustainable development approach. (1) Ecosystem services valuation, which assigns economic values to the benefits humans derive from natural environments, is a framework that can provide vital insight into the ecological costs of large-scale development projects. It can also be used as a way to incorporate local/traditional knowledge into decision-making. (2) Payments for ecosystem services programs, while effective in conserving and regenerating forests in developing countries, still have significant areas of improvement to be considered for similar future projects. Particularly, it has not been demonstrated that they are effective mechanisms for poverty alleviation, as it has been suggested in the literature. In fact, if not meaningfully supported, poor participants may face serious trade-offs and their involvement in such programs may negatively affect social capital in the community. (3) Service-learning, or working with communities to address real world-problems through a rigorous academic framework, is more effective at developing critical, ecological and civic literacy in students and develop more knowledgeable agents to solve the world's complex problems. Overall, these new and other tools must be developed to specifically address the ecological illiteracy that so often guides development decisions and be integrated into a comprehensive, inclusive framework for sustainable development.

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I dedicate this work to my niece, Sophia, and all those of her generation. I hope that the work we are doing now will lead to a better tomorrow for all of them.

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CHAPTER 1: INTRODUCTION

1. Introduction

The importance and contribution of healthy ecosystems to human well-being and poverty reduction has gained increasing awareness and attention in recent years. Perhaps the most significant example of this is the Millennium Ecosystem Assessment, launched by then U.N. Secretary-General Kofi Annan in June 2001, to provide a global, integrated evaluation of the current changes and consequences occurring within ecosystems. In this 2005 comprehensive assessment ecosystems are defined as “a dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as a functional unit” (p. V.). Intended for use by decision-makers and the public, the assessment highlights the vital role of ecosystems as they “contribute to human well-being and poverty alleviation” (MA, 2005, p. V.). There are various types of ecosystem services, including provisioning services, such as food, water and timber; regulating services that influence climate, water quality, floods and diseases; supporting services, including soil formation, photosynthesis and nutrient cycling; and cultural services that provide recreational, spiritual and recreational benefits (MA, 2005).

Despite this wide-scale acknowledgement, the majority of the benefits yielded by ecosystem services are currently exogenous to the economic system, so their value is not equally weighted in decisions that directly impact their functioning and well-being (Costanza et al, 1997a; Stratton, 2006; Turner et al, 2003). Therefore, public

understanding of the importance of these contributions and the necessity for healthy ecosystems is vital for their conservation. However, thorough understanding of what ecosystems are, how they function, and how to manage them on a systems-based level is lacking, in various publics, among policy-makers, and even in environmental managers (Daily, 1997). In fact, at the nexus of the complex environmental problems facing the world today is the lack of understanding of the impact of individual and aggregate actions, particularly on ecosystems.

Ecological Economics and Ecosystem Management for Sustainable Development

Ecological economics (EE) is an emerging field that seeks to reconcile the roots for this disconnect. It is defined as “the union of economics and ecology, with the economy conceived as a subsystem of the earth ecosystem” that must be aligned with thermodynamics and the recognition of finite resources (Daly and Farley, 2004). Traditionally, the inability to recognize the intrinsic dependency of the economy on earth systems leads to myopic and incomplete decisions that cause and amplify environmental problems, particularly when pursuing development agendas. A salient example of this is Brazil’s hydropower development projects, which led to the displacement of more than a million people and the inundation of over 34,000 square kilometers of land (IRN, 2000).

Ecological economics stresses the importance of actively engaging individuals and communities to expand comprehension of the interdependence and connectivity

of and between systems. It is considered a transdiscipline in that it cuts across multiple disciplines in order to address multi-faceted and multi-scale problems facing humanity (Costanza, 1989). EE focuses on the four capitals that contribute to human wellbeing – built, human, social and natural – equally in order to meet the goals of sustainable human and environmental health (Daly and Farley, 2004). Natural capital is defined as the land and the many resources it contains; built capital is considered all of the infrastructure such as buildings, roads, etc., that make up the human economy; human capital is education, information and physical labor of humans; and social capital is viewed as the web of interpersonal connections, institutional arrangements and rules and norms of human interactions (Costanza, 1989). Ecological economics focuses on efficient allocation, just distribution and scale to sustainably manage and protect the four types of capital.

As an emerging discipline, EE is actively developing new policies and tools in order to implement EE principles. Dynamic computer modeling is one such tool. These models provide a way in which complex systems can be more easily understood, and a means in which the gaps between cause and effect are closed. Although they have limitations, models are interactive tools that demonstrate the outcomes of choices made and how systems change, over time and from various alternatives (Costanza and Ruth, 1998). Another tool involves developing new quality of life measurements, such as the Genuine Progress Indicator (GPI), for a more comprehensive measurement of well-being than the Gross Domestic Product (GDP). Establishing a commons trust, in order to jointly manage and equally benefit

from common goods and services, such as air and water, is another EE tool. Promoting a steady-state economy, or one that is not based on ever-increasing economic growth, offers another example of an EE policy in development.

Sustainable Development

The term sustainable development was coined by the Bruntland Commission and has come to be known as development that “meets the needs of the present without compromising the ability of future generations to meet their own needs” (UN, 1987). In the four decades since its inception, the concept has become so ubiquitous that some argue it has lost its theoretical or policy relevance (Jacobs, 1999). Yet at its core, sustainable development attempts to effectively manage the four capitals. Gilbert et al., (1996) offer a starting point for sustainable development by identifying key characteristics:

Environmental Sustainability: Practices to ensure that the natural resource capital remains intact; i.e., that the “source” and “sink” functions of the environment should not be degraded. Therefore, the extraction of renewable resource should not exceed the rate at which they are renewed, and the absorptive capacity of the environment to assimilate wastes should not be exceeded. Furthermore, the extraction of non-renewable resources should be minimized and should not exceed agreed minimum strategic levels.

Social Sustainability: Practices to ensure that the cohesion of society and its ability to work towards common goals are maintained. Individual needs such as those for health and well-being, nutrition, shelter, education and cultural expression should be met.

Economic Sustainability: Occurs when development, which moves towards social and environmental sustainability, is financially feasible.

The lack of environmental considerations in sustainable development is being acknowledged in growing circles. From former Senior World Bank Vice President and Chief Economist and Nobel Prize laureate Dr. Joseph Stiglitz (2002, 2006) to the European Commission on Sustainable Development (2007), the call is clear: a comprehensive approach must be taken to simultaneously address economic, social and ecological needs.

There are also levels of sustainability: weak and strong. Weak sustainability proffers that each generation “has the moral obligation to keep the total stock of capital at least constant,” where the total stock is a mixture of natural and produced capital stocks (Krysiak, 2006, p.189). Therefore, manufactured capital of equal value can take the place of natural capital. In strong sustainability, however, all forms of capital must be maintained, independent of each other, implying a complementary rather than a surrogate relationship (Özakynak et al., 2004). Considering that there still remain substantial uncertainties in understanding the importance of and relationship between capitals, a comprehensive approach in sustainable development,

in accord with the precautionary principle, would be to follow the principles of strong sustainability.

Ecological Literacy and Pro-environmental Behavior

In order to promote those equitable principles, new strategies and policies must be developed based on thorough understanding of the dynamics and interdependence of these capitals and how they affect ecosystems. These approaches must take into consideration both individual and collective behavioral components. Traditionally, neoclassical economics, and subsequently policy, has been guided by emphasis on built capital, ignoring the magnitude of this interdependence and the other capitals' contribution to human well-being (Hawken et al., 1999). In fact, emerging research in economics, psychology and sociology, among others, demonstrates that focusing on purely material consumption (promoted by neoclassical economics) does not correlate well with health, happiness or environmental sustainability (Easterlin, 2003; Kasser, 2003; Layard, 2005). The recognition of the equal importance of the four capitals should therefore be the guiding influence to ensure appropriate policies are crafted and implemented for ecosystem management. This is particularly important to consider in development, as most development agendas are guided by the need for ever-increasing economic growth measured through GDP.

The neoclassical model is not the only theoretical framework that has failed to adequately address the multi-faceted nature of human decision-making that ultimately leads to pro-environmental behavior (or lack thereof). In fact, theories from psychology (such as intrinsic motivation), environmental sociology (such as attitudes

and identity processes), and neuroscience (including the cognitive load theory and recency effect), among others, that attempt to succinctly explain lack of environmental behavior on individual and societal scales have failed to appropriately encapsulate all aspects that drive pro-environmental behavior. On a large scale, this can be evidenced by the new report by the Inter-governmental Panel on Climate Change (IPCC) that calls for “not only continued development of sophisticated climate models...but also a new integration of those models with predictive descriptions of human behavior” (IGBP, 2007).

A more thorough model of pro-environmental behavior would include both individual and collective aspects of behavioral drivers. Ecological literacy, defined as “[the] capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems...defined in terms of observable behaviors...knowledge of key concepts, skills acquired, disposition towards the issues...” (Disinger and Roth, 1992, p.3), is an essential component of pro-environmental behavior. This is true on both individual and collective levels, yet models that incorporate its importance on both scales to develop a more robust approach toward ecosystem management are lacking.

This dissertation research proposes to not only formulate a more comprehensive model of pro-environmental behavior, but also investigate how to implement it in ecosystem management. As discussed below, pressing environmental issues demand immediate attention, even in the absence of full scientific data. This research, therefore, focuses on ecological economic tools and policies that highlight the

importance of the other three capitals to achieve environmental balance and well-being and advance appreciation of this interdependence while promoting ecological literacy for sustainable development. The central question of this research addresses: In what ways can the emerging field of ecological economics and specific tools promote ecological literacy and ecosystem management? The specific ecological economic tools investigated are: rapid assessment valuation, payments for ecosystem services and service-learning.

The following section will first discuss the overall aims of this research and its conceptual framework. An overview of ecological literacy and systems thinking will then be provided. The subsequent section will introduce the guiding methodology of this research, and present its driving research questions. In-depth descriptions of the projects will be the focus of the final section.

2. Conceptual Framework

This dissertation seeks to further these EE principles by advancing several cutting-edge ecological economic tools and examining their efficacy of ecosystem management and fostering ecological literacy through a mixed methods, case study research lens. Due to the urgent and complex nature of many environmental issues, there is not always time for long-term research before decisions are made. Hence, ecological economics promotes adaptive management, or changing policies as conditions change and as more is learned (Daly and Farley, 2004). This post-normal science approach incorporates “uncertainty, value loading, and a plurality of legitimate perspectives...in order to

provide a coherent framework for an extended participation in decision-making” (Funtowicz and Ravetz, 2007). This research uses several case studies to glean more textured knowledge of what variables contribute to successful development, implementation and compliance with ecosystem management approaches within a post-normal framework.

Systems Thinking

Systems thinking is defined as “a mindset for understanding how things work...it is a perspective for going beyond events, to looking for patterns of behavior, to seeking underlying systemic interrelationships which are responsible for the patterns of behavior and events” (Bellinger, 2004). Although the concept of systems thinking derives its roots from many of the great thinkers such as Descartes and Newton, it has gained increased attention in the past several decades (Jackson, 1991). Systems thinking purports that cause and effect are not close in time and space. Current paradigmatic thinking, however, most often does not recognize this delay, causing a “fundamental mismatch between the nature of reality in complex systems and our predominant ways of thinking about that reality” (Senge, 1990).

This disconnect usually leads to decision-making that is myopic, short-termed, and does not adequately address linkages between systems. The complex issues facing humanity, however, clearly evidence that there is a need to develop an understanding of the functioning of and between systems. This is particularly true in the environmental realm, where individuals, as well as societies, often do not acknowledge the connections

between actions and environmental impacts, demonstrating a deficiency of ecological literacy that perpetuates non-environmentally-based behavior. The development of horizontal thinking, or understanding of linkages across systems, requires a shift of perspective as well as educational foci (Richmond, 2005). There has been an exhaustive discussion in the literature of ‘sustainability’ and how societies can achieve this, with consensus that behavior modification - both individual and collective - is the necessary outcome. Yet without the development of systems thinking and ecological literacy, sustainability will remain elusive, as understanding is the first step of behavior change.

Ecological Literacy

The concept of ecological literacy is still in its nascent stages. While there is not one standard explanation that allows uniform understanding of it, there have been attempts at laying a common framework for comprehension. As introduced above, Disinger and Roth (1992), considered to be the founding fathers of ecological literacy, offer a widely accepted definition: “[the] capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems...defined in terms of observable behaviors...knowledge of key concepts, skills acquired, disposition towards the issues...” (p.3).

This definition outlines a more complex relationship between environmental understanding and behavior. In fact, to further explicate this multifaceted relationship, the National Project for Excellence in Environmental Education delineates four elements of ecological literacy:

- 1) knowledge of environmental processes and systems
- 2) skills for understanding and addressing environmental issues
- 3) questioning and analysis skills
- 4) personal and civic responsibility

(EETAP, 2004).

The final component asserts that individuals and society have a responsibility to advance environmental protection and conservation, thereby incorporating individual and collective behavior change in its rubric. Environmentally responsible behavior is a broad term that encompasses multiple facets but generally refers to “behavior compatible with the maintenance of an environment that will promote the well-being and survival of the whole society, rather than one which is beneficial only to an individual or group of individuals” (Hsu and Roth, 1998). This inherently includes both individual and collective action in its definition, establishing the need for a dual-pronged model that identifies components of pro-environmental behavior.

Toward a More Comprehensive Pro-environmental Behavioral Model

Ecological economics challenges the standard, narrow-minded paradigm and demands a more systems thinking approach when addressing complex environmental problems. It asserts that the way to operationalize this approach is through a shift in the dominant worldview (Brown and Cameron, 2000; Daly and Farley, 2004; Orr, 2004). Clearly these alterations in worldview do not occur easily or rapidly; enabling this transformation requires a thorough understanding of what elements are involved to

promote this change. An important first step requires an abandonment of the neo-classical *Homo economicus* model of behavior, which asserts that humans possess ‘perfect’ rationality, self-interest and knowledge that will lead them to act to attain the highest possible material well-being for themselves given available information about opportunities and other natural and institutional constraints (Daly and Farley, 2004).

Counter models have been developed that strive to demonstrate that individual behavior is often driven through a variety of factors, including exposure to alternative choices, active participation, the influence of mass media and strong social networks (Brown and Cameron, 2000; Dandaneau, 2001; Putnam, 2000; Wallack et al., 1999). In his *Homo ecologicus* model Becker (2005) asserts that humans’ relations with nature are not based on self-interest or solely for biological survival, but incorporate sympathy for nature, connection to nature’s creativity and connection through personal experience as important elements of the human actor.

Some environmental education models suggest that once a person has knowledge and feels empowered to take action, behavior change may readily follow. E.O. Wilson (1984) first coined the term *biophilia*, positing that there is an instinctive bond between humans and other living systems that must be drawn out in order to create knowledge and empowerment. Sobel (2004), Orr (2004) and others argue that we must cultivate this *biophilia* through place-based learning - “the process of using the local community and environment as a starting point to teach concepts in language arts, mathematics, social studies, science, and other subjects across the curriculum” (Sobel, 2004, p. 7) - in order to develop ecological literacy. Adding to the environmental education models, Hungerford

and Volk (1990) determine that ownership variables (including in-depth knowledge about issues and personal investment in the environment) and empowerment variables (knowledge of skills in using environmental action strategies and locus of control) need to be developed in order to promote pro-environmental behavior.

Hagens (2007), drawing from economists, sociologists and psychologists, argues that there are a multitude of factors that formulate cognitive belief bias that leads to unsustainable behavior, particularly in the realm of peak oil and climate change. Some of these components include:

- Cognitive load theory: (from Shiv and Fedorikhin) humans have a maximum capacity of working memory – after a certain amount of information, humans' working memory becomes saturated and new material can not be accepted without losing some of the previous information
- Recency effect: (from Frensch; Healy, Havas & Parker) people tend to put more emphasis on the most recent data and stimuli they receive in their decision-making processes – these items usually remain in the working memory when recall is solicited
- Discount rates: (from McClure, Laibson et al., and others) humans favor the present over the future and will thus make more decisions geared towards living in the moment
- Risk aversion: (from Arrow and Pratt) people prefer a certain but possibly lower payoff than an uncertain but possibly higher payoff

- External validation – (from Milgram) humans tend to have a belief in authority figures, thereby making them more apt to listen to messages from mainstream media

Some theorists highlight the importance of the effects of societal influences on behavior in various interpretations of social learning theory. Bandura (1986) and Ormand (1999) describe how learning occurs within a social context, through observation, imitation, cognition and environmental reinforcement. Hernandez and Iyengar (2001) look at the influence of culture and how that drives human motivation and behavior. In cross-cultural studies, they found that people from more interdependent cultures (such as Asian communities) are more likely to be collectively agentic, whereas people from Western communities that stress independence are more likely to be personally agentic. Building on social network theory, Putnam (2000) posits that social networks have value and that social contacts can affect the productivity of individuals and groups. Table 1 offers an overview of these concepts.

<i>Model, Author(s)</i>	<i>Homo economicus</i> Smith, 1759	<i>Social Learning Theory</i> Bandura, 1977, 1984; Ormmand, 1999	<i>Social Change</i> Wallack, Woodruff, Dorfman and Diaz, 1999	<i>Theory of Environmentally Significant Individual Behavior</i> Stern, 1995, 2000
Essential Components	<ul style="list-style-type: none"> • Perfect self-interested rationality • Seeks to attain the highest possible material 	<ul style="list-style-type: none"> • Learning occurs within a social context • Learning occurs via observation, imitation, cognition and environmental reinforcement 	<ul style="list-style-type: none"> • Using the media can effectuate social change 	<ul style="list-style-type: none"> • Attitudinal, Personal capabilities, contextual factors and habit and routine are all causal variables that influence environmentally significant behavior
<i>Model, Author(s)</i>	<i>Social Capital</i> Putnam, 2000	<i>Reduction of Overconsumption</i> Brown and Cameron, 2000	<i>Homo ecologicus</i> Becker, 2005	<i>Place-based Education, Development of Biophilia</i> Wilson, 1984; Orr, 2004; Sobel, 2005
Essential Components	<ul style="list-style-type: none"> • Social networks have value • Social contacts affect the productivity of individuals and groups 	<ul style="list-style-type: none"> • Individual adoption of a pro-environmental worldview will lead to consumption reduction 	<ul style="list-style-type: none"> • 3 levels of the human relationship: 1) the relation of the human being with itself, 2) the relation of the human being with other humans and 3) the relation of the human being with nature 	<ul style="list-style-type: none"> • There is an instinctive bond between humans and other living systems (<i>biophilia</i>) • Using the local community and environment as a starting point to teach concepts in all subject areas across the curriculum will develop <i>biophilia</i>, an essential step in ecological literacy formation
<i>Model, Author(s)</i>	<i>Education for Sustainability</i> PCSD, 1999	<i>Teaching Global Environmental Change</i> Thomashow, 2002	<i>Components of Individual Pro-environmental Behavior</i> Hungerford and Volk, 1990	<i>Cognitive Belief Biases That Inform Environmental Behavior</i> Hagens (drawing from others), 2007
Essential Components	<ul style="list-style-type: none"> • Refinement of knowledge and skills leads to an informed citizenry committed to responsible individual, collaborative actions resulting in an ecologically sound, economically prosperous, and equitable society for present and future generations 	<ul style="list-style-type: none"> • Understanding global environmental change will lead to understanding's humans role in environmental stewardship 	<ul style="list-style-type: none"> • Ownership and empowerment variables need to be developed to promote pro-environmental behaviors 	<ul style="list-style-type: none"> • Cognitive load theory, the recency effect, discount rates, external validation, risk aversion, and cognitive dissonance all contribute to individual environmental behavior

Table 1-1: Overview of Models of Behavior

Reflecting upon the contributions of these theories, it becomes clear that there are significant influences on individual behavior and knowledge development, as well as important effects that societal rules and norms have on collective conduct. In fact, the above discussion illuminates that while there are many approaches to explaining individual and societal behavior, there is not a cohesive model that adequately takes into account the individual and collective components that stimulate ecological literacy and form pro-environmental behavior, and that their interaction can in turn lead to synergistic behavioral development on both an individual and collective level. Figure 1-1 illustrates these relationships and proposes a new model that recognizes the multi-faceted associations between individual and collective behavior, and how the relationship between the individual and the community can, in turn, lead to synergistic development of ecological literacy that ultimately drives pro-environmental behavior.

This research aims to identify channels that can exploit the synergistic potential of individual and collective behavior to develop ecological literacy and drive ecosystem management. The next section discusses the methodologies that will be employed for this endeavor.

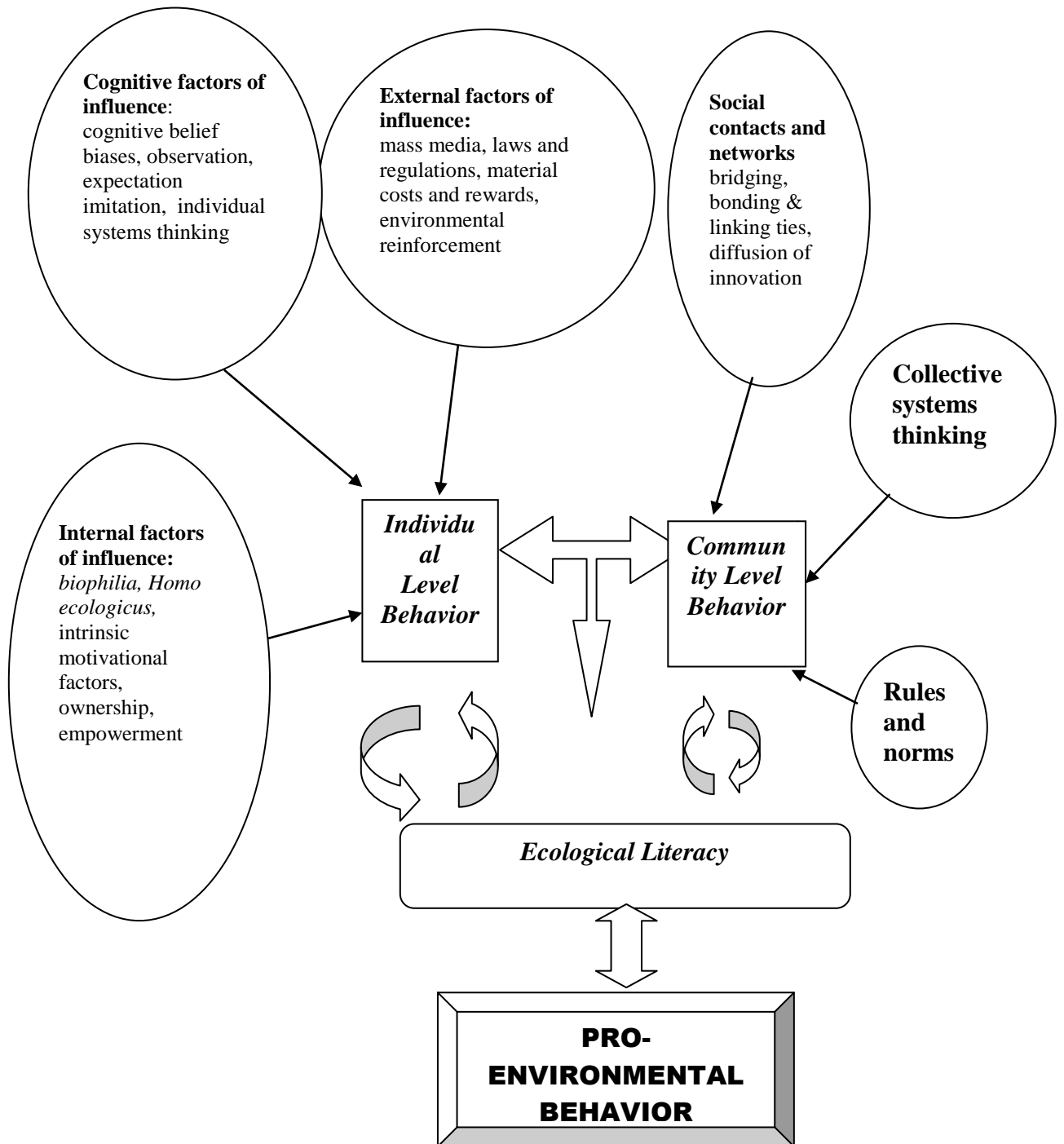


Figure 1-1: A Comprehensive Model of Individual and Collective Components to Pro-environmental Behavior

3. Methodology Overview

Since natural capital is a shared capital, there needs to be a collective approach to decision-making and management regarding its use. One major goal of ecological economics is developing new management tactics that advance this principle. Ideally, these management approaches will highlight the diverse skills, knowledge and abilities of people as they collectively make decisions, providing the space for contribution of individual knowledge, while recognizing their role in the greater community and biosphere, thereby engendering ecological literacy and promoting pro-environmental behavior on individual and collective levels. Since natural capital management inherently includes many complex problems, community-based management could potentially produce a synergistic development of communal ecological literacy. That is, together a community will have a greater understanding of complex systems, systems thinking and ecological literacy than each individual member.

In order to determine efficacy of the ecological economic tools being used in this research, it is necessary to apply not only the tools themselves, but also a framework for understanding if and why the tool is working. The particular methods of creating and applying the tools will be presented in the discussion of each project.

Post-Normal Science

All of these projects deal with, on some level, the interface of implementing a management tool with a local community or group of people. As such, there can be a vast difference in the theoretical application of a policy or approach and the reality of

how it is actually implemented. In fact, this is often the case in development projects. For example, many soil conservation projects in developing countries failed to be implemented successfully because there was not been enough consideration of indigenous or local methods of soil management (Critchley, 1999; Kent, 2001). However, once a view of land management and technology development that incorporated cultural, individual and external sources of knowledge was constructed, higher success rates were achieved (Kent, 2002; Reij et al., 1996; Simpson, 1999).

Considering that the EE approaches utilized in this research are novel, there is an inherent need to continuously examine if their theory is being applied appropriately and effectively, a critical element of adaptive management. In fact, as a post-normal science, EE research must implicitly have a positive-feedback loop of tool/policy development, application, continued research, evaluation, reflection and then back to tool/policy development to begin the iterative process again. Figure 2 illustrates this relationship.

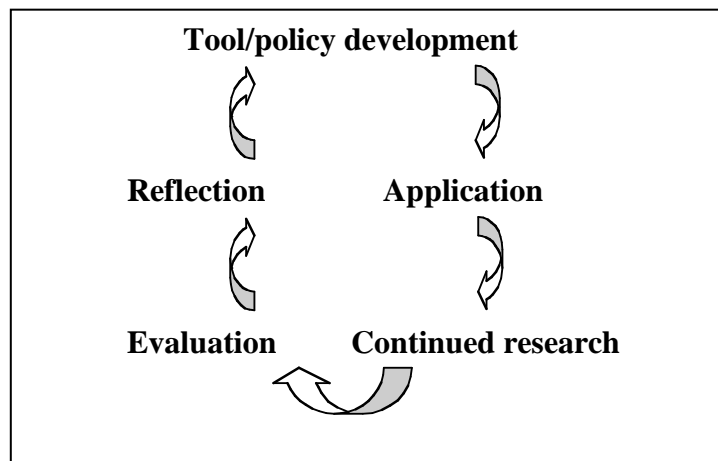


Figure 1-2: The Elements of Adaptive Management in Post-normal Science

Bodorkos et al., (2005, p.2) present the necessary elements of EE research:

Ecological economics as a post-normal science is not striving to deliver truth or objective reality anymore (Funtowicz-Ravetz, 1993), much rather [*sic*] to seriously reflect upon the social and ethical consequences as well as values and ideologies of its works (Söderbaum, 1999). Democratization of knowledge, openness, self-reflectivity, awareness of one's assumptions, values and explicit statements, plurality of perspectives, continuous process of reflection, the presence of a extended peer-community who take part in the quality assessment of information (Funtowicz-Ravetz, 1994) in the research process and in the production of scientific knowledge as well, are considered to be the most important elements of post-normal science (Müller, 2003; Tacconi, 1998; Funtowicz-Ravetz, 1994).

Case Study Research

A mixed method, case study approach provides an ideal technique to further these post-normal principles (ie. the democratization of knowledge, plurality of perspectives and awareness of one's assumptions), given that it provides the space for both quantitative and qualitative evidence in research. Creswell explains mixed methods provide for “multiple methods, different worldviews, and different assumptions, as well as different forms of data collection and analysis” (p. 12). Yin defines the case study method as “an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not clearly

evident; and in which multiple sources of evidence are used” (Yin, 1984, p.23). Case study methodology has the capacity to offer purposive, situational or interrelated descriptions of phenomenon, connecting practical complex events to theoretical abstractions (Stake, 1995). The best way to examine the need for, application and efficacy of an ecological economic policy or approach would be to study it in its natural setting, using qualitative and quantitative approaches, which mixed methods and case study enable.

The inherently shared nature of ecosystems and the fact that their services impact everybody on the planet necessitate that the multiple perspectives that people hold about them, and that guide their management and stewardship, must be understood in-depth. Hence, this research also examines the qualitative aspects of the projects in an attempt to uncover those more intangible (but quite relevant and important) variables that affect project outcomes. Qualitative research provides a naturalistic paradigm that develops hypotheses that are time and contextually bound and recognizes that inquiry is value-bound (Lincoln and Guba, 1985). It seeks to gain greater insight to understanding social phenomena, including understanding perspectives and attitudes that underlie behavioral patterns (Marshall and Rossman, 1999). It is particularly useful to understand the way that individuals experience a particular process and how they interpret and ascribe meaning to this occurrence (Morse and Richards, 2002). This method is particularly appropriate, then, for this research, because it seeks to not only apply these novel tools, but also examine what factors promote success. Using qualitative research to determine how to best implement ecological economic projects is inherently aligned with the core

tenets of EE and adaptive management in post-normal science, as the underlying assumptions of qualitative research include the notions that “reality is socially constructed, variables are complex, interwoven and difficult to measure... [whose approach] seeks pluralism [and] complexity” (Glesne, and Peskin, 1992).

Understanding the experience of the people involved in these projects and the socio-cultural context is vital to comprehending the success of the tools. Case study, mixed methods facilitate in-depth investigation of how and why the projects are working, as well as factors that affect participants, in a framework that will allow for adaptive management to design and adjust appropriate projects that balance the four capitals. This research aims to add to the emerging literature discussion in ecological economics, ecosystem services, systems thinking and ecological literacy. The next section discusses the driving research questions as they fit under the umbrella of the central guiding question of this dissertation: how can ecological economics promote ecological literacy and ecosystem management?

4. Driving Research Questions

In order to investigate if emerging ecological economic methods advance the development of systems thinking and ecological literacy and balance the importance of the four capitals for ecosystem stewardship, this research will be guided by the following questions:

- 1) How can the use of rapid assessment for ecosystem services valuation be used to promote public participation and integrate systems thinking into decision-making

about large-scale development projects? How can this method incorporate indigenous and local knowledge (human capital) in a manner that ensures long-term natural capital health?

2) Are payment for ecosystem services programs successful at managing natural capital? What are important variables for long-term participation for small landowners in payments for ecosystem services programs? Do payment for ecosystem service programs adequately take into account the role of ecological literacy and the importance of just distribution for poor participants? What is the role (if any) of social capital in increasing participant retention?

3) Does service-learning enhance systems thinking (and human capital) in students? What elements are successful and what are areas of improvement to better implement service-learning in ecological economic curricula?

5. Projects Descriptions

This mixed method, case study approach will be used in the four projects that are broken down into five articles and described below. Table 1-2 provides an overview and descriptions follow.

Article	Topical Areas Covered	Methodology	Key Research Questions
1 – Rapid Assessment Valuation, Camisea, Peru	<ul style="list-style-type: none"> • Application of Rapid Assessment Valuation • Use of Public Participation in Large-scale Infrastructure Development 	<ul style="list-style-type: none"> • RAV • Semi-structured, in-depth interviews of indigenous community leaders, government and ngo organizations • Public participation analysis 	<ul style="list-style-type: none"> • How can the use of rapid assessment for ecosystem services valuation be used to promote public participation and integrate systems thinking into decision-making about large-scale development projects? • How can this method incorporate indigenous and local knowledge (human capital) in a manner that ensures long-term natural capital health? • Are payment for ecosystem services programs successful at managing natural capital, particularly at the national level?
2 – Analysis of Costa Rica’s PES program	<ul style="list-style-type: none"> • Analysis of successful elements and areas of improvement in CR’s PES program 	<ul style="list-style-type: none"> • Document and data analysis 	
3 – Considerations of Poor Landowners in Costa Rica’s Payment for Ecosystem Services Project	<ul style="list-style-type: none"> • The experience of poor landowners • The role of ecological literacy and social capital in program participation 	<ul style="list-style-type: none"> • Semi-structured, in-depth interviews with poor landowners • Interviews with key government NGOs • Analysis of emergent themes 	<ul style="list-style-type: none"> • What are important variables for long-term participation for small landowners in payments for ecosystem services programs? • Do payment for ecosystem service programs adequately take into account the role of ecological literacy and the importance of just distribution for poor participants? • What is the role (if any) of social capital in increasing participant retention?
4 – Service-Learning and Ecological Economics Outreach	<ul style="list-style-type: none"> • Role of service-learning in ecological economics outreach • Elements of success, areas of improvement in service-learning education 	<ul style="list-style-type: none"> • Triangulation methodology: surveys, observations and document analysis 	<ul style="list-style-type: none"> • Does service-learning enhance systems thinking (and human capital) in students? What elements are successful and what are areas of improvement to better implement service-learning in ecological economic curricula

Table 1-2: Overview of Projects

Chapter 2 provides an in-depth application of rapid assessment valuation. Ecosystem Services Valuation (ESV) is an ecological economic approach that identifies and values the functions, goods and services produced by ecosystems that benefit human populations (Costanza et al., 1997b). ESV has been the subject of a substantial amount of debate but is increasingly gaining recognition as a way to integrate the value of natural systems into an otherwise incomplete decision-making analysis (MA, 2005; Stratton, 2006).

At the core of the tenets of ecological economics of scale, distribution and allocation is the concept that natural capital is a shared resource, placing ecosystem services in the public realm and recognizing that decisions made about their usage and management merit public input. This should be especially true in large-scale development projects, given the resource demands and pressure that such projects place on the environment and local communities, as well as the fact that these projects have direct impact on many people in the host countries. The public should own the participation process, as they are the true owners of the natural resources that will be exploited. Yet all too often, the lay public is completely excluded from the decision-making process, peripherally included, or the procedure is co-opted by those in charge (Alterman 1982; Beirele 2002; Kasemir 2003). Incorporating an inclusive participatory process in environmental decision-making provides the opportunity to integrate local environmental knowledge and democratizes the planning process.

The research in Chapter 2 examines the financial, ecological and social impacts and policy implications of not incorporating ESV or an open participatory process in the Camisea Pipeline Project, a highly controversial transnational natural gas pipeline project

in Peru that has led to significant environmental and social impacts. The gas and condensate fields are located in the Camisea area of Peru, an area of pristine Amazon rainforest and a Conservation International designated biological hotspot. Although the project is heavily subsidized by the Inter-American Development Bank (IDB), it has had major detrimental impacts to the indigenous peoples living within the area of influence of the pipeline and the project has set dangerous precedent for further mandrel exploitation projects throughout the Amazon region. The pipeline has already experienced an unprecedented five spills in less than two years of operation, evidence of poor planning, implementation and monitoring policies.

In this analysis, rapid assessment valuation (RAV) of ecosystem services was conducted in order to compare it to the results of the economic impact study performed by the consortia of oil and pipeline companies involved in the project. Through the ESV, the impact to ecosystems was demonstrated and the true cost of the pipeline determined.

Results demonstrate that billions of dollars in ecosystem damage were lost due to inaccurate accounting. For future development projects, RAV or ESV can be applied to provide a more wide-ranging framework on which to base development decisions.

Chapter 3 provides a comprehensive evaluation of a market-based mechanism for conservation. Payment for Ecosystem Services (PES) is a relatively new approach to conservation management. Environmentalists, economists and governments are increasingly recognizing the importance of healthy ecosystems for continued provisioning of their services. Through payments schemes, private landowners are compensated for conserving their land in order to ensure ecosystem health. For example,

in New York, upstream farmers are paid for retaining and restoring riparian buffer zones (Chichilnisky and Heal, 1998). In Costa Rica the government compensates landowners for reforestation and forest conservation for maintenance of a clean water supply, carbon sequestration and other services provided by healthy forests, in the first PES program on a national scale (Pagiola, 2002). While various schemes have been successful, this is a relatively new approach to conservation management and requires the cooperation of many players. Ultimately the perceptions of both providers and users shape the formation of such projects and much more research is needed to understand what factors lead to enduring sustainability. The purpose of this article is to assess the 10-year old Costa Rican PES project to determine successful elements, identify problems, and offer potential solutions.

Focal topics include: opportunity costs; institutions, scale matching and bundling services; targeted payments; equity – free riding and poverty alleviation considerations; technical issues; accountability and governance and sustainable financing. Analysis reveals areas that are in need of improvement and new methods of an adaptive framework for institutional designs, flexible mechanisms for estimating opportunity costs and other management options are recommended.

Some of the biggest gaps in research involve qualitative aspects of PES projects (Kosoy, et al., 2007). This includes understanding what perceptions and values shape decisions made by stakeholders involved in PES, variables that are key components in ecological literacy and predictors of long-term participation and project compliance. There has also been considerable discussion in the literature about the sometime disparate

goals of PES programs, conservation and poverty alleviation. FONAFIFO states that one of the original goals of the PES program was to “benefit the small and medium landowners...whose lands possess forest or capability for forest cover” and the organization asserts that Costa Rica’s PES program has positively contributed “to rural development,” (FONAFIFO website, 2005). While this does not delineate that poverty alleviation is an explicit objective of the PES program, it is implicit as an aim of the program. Yet examination of the main beneficiaries of the Costa Rican PES program reveals that the majority of the participants are medium and large landowners who have other main sources of income, even while there are often highly spatial correlations between poor areas of small landowners and those with high environmental services (Landell-Mills and Porras, 2002; Miranda et al., 2003; Pagiola, 2006; Zbinden and Lee, 2005). In Chapter 4 qualitative research is applied to gain greater insight into the factors that promote or inhibit small landowner participation in the PES program. Interview protocols included questions investigating overall thoughts about the program and potential facilitators and barriers to participation.

Analysis reveals that many participants belong to the program despite the small amount of compensation. Social capital may be adversely affected in the community, due to negative views of the program by non-participants. Small landowners often feel isolated and lacking support from government institutions, with major hindrances or barriers of participation including deficiencies of information and guidance, lack of targeted recruitment and high transaction fees. This research adds to the emerging literature on PES and poverty alleviation and will guide better development and

endurance of future PES projects, particularly focusing on issues of equity, qualitative understanding of program design and poor landowner participation and retention.

In Chapter 5 service-learning is examined to ascertain if it is an effective pedagogical approach for ecological economics curricula. EE focuses on problem-based learning to tackle real-world problems and enhance student understanding of complex issues. Service-learning is defined as “a form of experiential education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and development...[with] reflection and reciprocity [as] key concepts of service-learning” (Jacoby, 1996, p.3). Service-learning therefore offers another dimension to problem-based learning: engendering university-community partnerships to meet community needs while providing students with structured opportunities for applied learning. Through service-learning courses, students and communities pool resources and knowledge to work towards sustainable solutions to multifaceted problems. Due to the complex and multifaceted nature of most, if not all, environmental problems, service-learning provides unique methods for students to gain critical-thinking and systems-thinking skills and apply ecological economic problem-solving approaches to address environmental, economic and social conditions.

The chapter examines four case studies of service-learning courses for successful elements and areas needing improvement. Three of the courses are internationally focused: a travel course that examined HIV/AIDS and poverty in the Dominican Republic; a travel course that investigated the payment for ecosystems services program

in Costa Rica; and a domestic course that had international partners to investigate the Camisea Pipeline Project in Peru. The fourth class engaged in local community workshops to conduct dynamic systems modeling about tourism issues in the Northern Forest in Vermont, New Hampshire and New York.

Analysis reveals that students become more vested in their work when real-world clients are involved, gain deeper insight into complex problems and systems-thinking and are more likely to make future choices based on their experiences in the service-learning class. Areas to be addressed include: reflection, long-term follow-up and providing extended opportunities to work on the project beyond the tenure of the course to avoid student and/or community feelings of abandonment. The article concludes with discussion and recommendations for successful incorporation of service-learning into ecological economics curricula.

Chapter 6 offers final comments on this research, including an evaluation of how each tool fits into a sustainable, ecological economic framework, to examine their strengths and weaknesses and how each can be best utilized to contribute to effective ecosystem management in a comprehensive sustainable development framework.

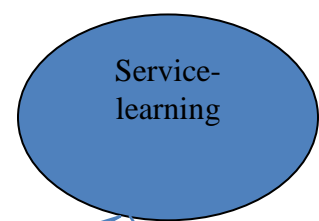
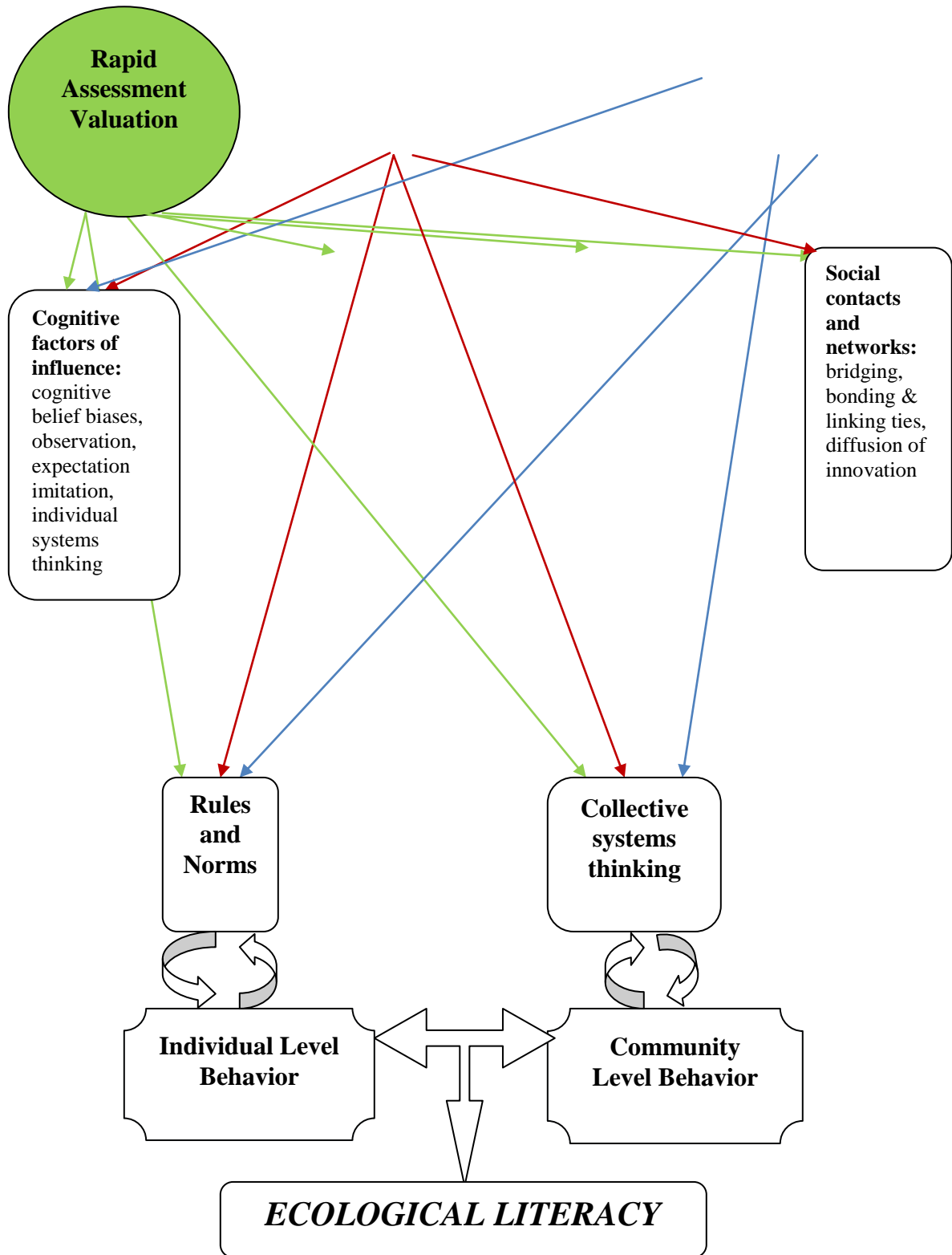


Figure 1-3: Components to Pro-environmental Behavior with Research Tools



CHAPTER 2: A RAPID ASSESSMENT VALUATION FRAMEWORK FOR ECOSYSTEM SERVICES VALUATION: THE CAMISEA PIPELINE CASE STUDY¹

Chapter Summary

Ecosystem services valuation (ESV) has emerged as an ecological economic approach that provides a more thorough examination of potential impacts of projects that involve land use change. Through analysis of the Camisea Project, a highly controversial transnational natural gas pipeline project in Peru, a template for rapid assessment valuation is introduced. This framework offers a reliable and timely method for ESV that provides space for public participation to be incorporated in decision-making processes with limited resources. This article examines the financial, ecological and social impacts and policy implications of not incorporating ESV in the Camisea Project. Figures derived from several scenarios are compared to project estimates for compensation and expected revenue and analyzed. Using conservative figures, it is estimated that ecosystem services values losses range from approximately \$8 to \$199 billion in the short- and long-term, while the total project cost is estimated at \$1.6 billion and expected to generate \$4.8 billion cumulatively. While the criticisms of applying ESV as a direct benefits accrual are recognized, results demonstrate that not incorporating ESV and public participation in the planning stages caused a loss of billions of dollars in goods and services and public trust as well as significant environmental damage. A systems-

¹ Written with Roelof Boumans and Saleem Ali

approach to development must include ESV and public participation to promote more sustainable outcomes

1. Introduction

As the world's burgeoning energy demands increases, energy infrastructure development has come to the forefront of multilateral development institutions' priorities. Natural gas is emerging as a cleaner and less controversial fossil fuel alternative than oil, given the current geopolitical, ecological and supply issues pertaining to petroleum. However, increasing evidence also suggests that it is by no means a panacea, with decreasing availability and difficult accessibility to remote new sources (EIA, 2006a). Nonetheless, natural gas pipeline development has been given high priority by multilateral development institutions, (as seen recently in the Shwe and Brazilian pipeline projects), even though these projects may cause significant impact to local peoples and the environment (USAID, 2004). As exploration and exploitation of natural gas increases in isolated areas, the potential damage to intact ecosystems is also amplified.

The importance and contribution of healthy ecosystems to human well-being has gained increasing awareness and attention in recent years. Perhaps the most significant example of this is the Millennium Ecosystem Assessment, launched by U.N. Secretary-General Kofi Annan in June 2001, to provide a global, integrated evaluation of the current changes and consequences occurring to ecosystems. Intended for use by decision-makers and the public, the assessment highlights the vital role of ecosystems as

they “contribute to human well-being and poverty alleviation,” (MA, 2005; Carpenter, 2006a).

Despite this wide-scale acknowledgement, currently the majority of the benefits yielded by ecosystem services are exogenous to the economic system; hence their value is not equally weighted in decisions that directly impact their functioning and well-being (Costanza, 1997b; Straton, 2006; Turner et al., 2003). Ecosystem Services Valuation (ESV) is an ecological economic approach that identifies and values the functions, goods and services produced by ecosystems that benefit human populations (Costanza, 1997b). ESV has been the subject of a substantial amount of debate, but is increasingly gaining recognition as a way to integrate the value of natural systems into an otherwise incomplete decision-making analysis (MA, 2005; Economist, 2005; Foster and Gough, 2005; Straton, 2006). The Millennium Assessment stresses the importance of healthy ecosystems to provide services for poverty alleviation (MA, 2005; Carpenter, 2006b).

Ecological economics focuses on issues of scale, distribution and allocation (Costanza, 1997a; Daly, 2004). At the core of these tenets is the concept that natural capital is a shared resource, placing ecosystem services in the public realm, and recognizing that decisions made about their usage and management merit public input. This should be especially true in large-scale development projects, given the resource demands and pressure that such projects place on the environment and local communities, as well as the fact that these projects have direct impact on many people in the host countries. Ideally, the public should be included in the participation process, in order to promote a more fair and transparent process. Yet all too often, the lay public is

completely excluded from the decision-making process, peripherally included, or the procedure is co-opted by those in charge (Alterman, 1982; Beirele, 2002; Kasemir, 2003). The Camisea Pipeline Project throughout the country of Peru provides a prime example of a liquid natural gas pipeline project that was developed without meaningful participation or consideration of the value of ecosystem services, and has already yielded detrimental consequences.

Considering plans for additional phases of the project, and further recent discoveries of additional natural gas reserves throughout the region, this initial project is most likely a harbinger of future natural gas and oil exploration and exploitation in the Amazon, venturing into pristine lands and indigenous peoples' territories. Scrutiny of the flawed Camisea project reveals that due to the incomplete economic analysis, billions of dollars were lost due to damaging intact ecosystems, and public trust was severely affected. This paper aims to bridge the gap between ESV and public participation in development projects, particularly given the aforementioned potential for natural gas projects throughout the Amazon. Examination of this project can shed light on practices that failed and how future development trajectories can evolve with sound public participation processes and the incorporation of ESV to produce a more complete systems-approach to development.

2. The Camisea Region

The Lower Urubamba and Camisea region lie in one of the last untouched areas of the Amazon in eastern Peru. A place of unequaled biological diversity, this designated refuge area is considered by many scientists to be a biological 'hotspot', the classification

for an area that contains large numbers of endemic species not found in other areas (Myers, 2000). This term also includes areas that have a wide range of flora and fauna, whose characteristics include high amounts of species diversity, rare or threatened species, as well as species that are native to that particular area, and are especially threatened by human activities (Cincotta et al., 2000). In fact, Conservation International has defined the Tropical Andes as “the richest and most diverse region on Earth, containing about 1/6 of all plant life in less than 1% of the world land area,” (CI, 2007). According to the Smithsonian Monitoring and Assessment Biodiversity in the Camisea region there are 152 different plant species per hectare, 198 species of birds, 118 fish species and 86 reptile species and more than 100 species of bats, rodents and other small mammals (Smithsonian, 2007).

The Camisea region is also home to numerous indigenous communities such as the Machiguenga peoples, as well as semi-nomadic voluntarily isolated peoples such as the Nahua, Nanti, and Kirineri (Amazon Watch, 2006; Caffrey, 2002). These communities often live completely outside the economic market; their lives are entirely dependent upon healthy ecosystems (Amazon Watch, 2005). The Peruvian government created the Nahua Kugapakori State Reserve in 1990 in response to increased encroachment upon indigenous peoples’ land by logging companies and migrants. Article 89 of the Peruvian Constitution explicitly states “rural and native communities are legally recognized and enjoy legal status...ownership of their land is imprescriptible except in the case of abandonment...the government respects the cultural identity of the Rural and Native Communities,” (GoP, 2006).

2.1 The Camisea Pipeline Project – History

This area also contains vast natural gas and liquid natural gas reserves that were discovered in the first part of the 1980s. They were originally exploited by the Royal Dutch/Shell Group, but in the latter part of that decade Shell's contracts were annulled due to the project's unpopularity with the public. Since then, the political climate has changed, and the government issued that exploitation should resume, given that the resources are used only in Peru (Landers, 2006). After a negotiation process that designated that the gas would first be supplied to Peru for its energy needs, and the remainder could be exported, Hunt Oil and several other companies took over the project (Amazon Watch, 2005; Landers, 2006). Approximately 8.7 trillion cubic feet of natural gas and more than 482 million barrels of liquid petroleum gas are estimated in the Camisea oil field (EIA, 2006b).

In 2001, the Inter-American Development Bank (IDB), a financial lending institution, became interested in this large infrastructure project. The IDB is self-described as “the oldest and largest regional development bank...the main source of multilateral financing for economic, social and institutional development projects as well as trade and regional integration programs in Latin America and the Caribbean” (IDB, 2005). In September of 2003 the IDB approved \$135 million in financing the transportation portion of the Camisea project, considering it “one of the key energy infrastructure projects in Latin America” (IDB, 2005). A consortium of petroleum and pipeline companies, whose major players include Texas-based Hunt Oil and Argentine-based Pluspetrol and Peruvian-based Transportadora de Gas del Peru (TGP), completed

the first phase of construction in 2005 on a pipeline that transports the natural gas from the forest, across most of the country, to Lima, for exportation (Amazon Watch, 2006; Caffrey, 2002). Pluspetrol is considered the “operator of the Camisea Gas Project” the result of a contract awarded under public bidding held on Feb. 16, 2000 (PlusPetrol, 2004). The consortium completed the first phase of construction in 2005 on two pipelines (referred to as the pipeline) that transport the natural gas from the rainforest. One pipeline stretches 335 miles and carries liquid natural gas from the Malvinas processing plant (located 267 miles east of Lima) to the fractionation plant, south of Pisco on the coast. The other is a 443 mile natural gas pipeline, running from Las Malvinas to Pisco and Pisco to Lima for exportation (Amazon Watch, 2005; Caffrey 2002). Figure 2-1 demonstrates a view of the entire pipeline.

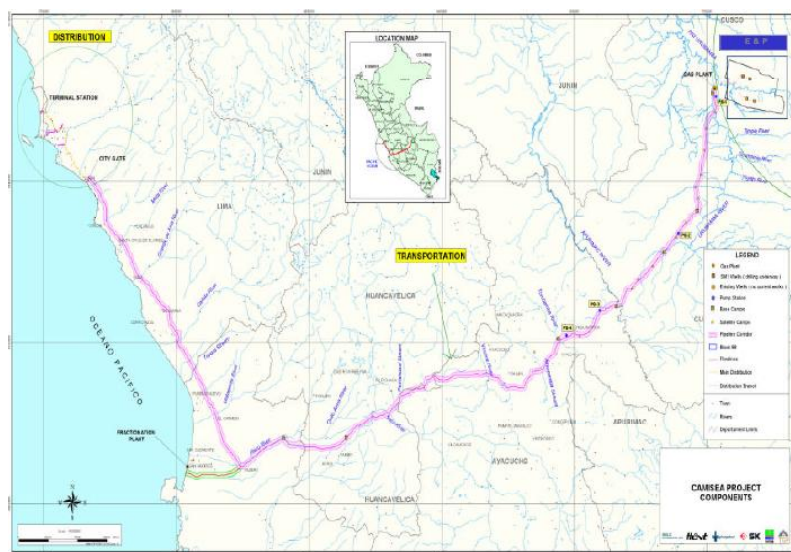


Figure 2-1: The Camisea Pipeline Source: Inter-American Development Bank

2.1.1 IDB Funding And Project Development

Due to the weighty environmental and social consequences many financial institutions, including the World Bank, rejected financing the project (Amazon Watch, 2005). However, in September of 2003 the IDB agreed to sponsor the project, providing the consortium a \$60 million direct loan and a \$75 million syndicated loan. The IDB was already the subject of criticism for its lax environmental standards; its 450-word environmental policy, crafted in 1979, provided the framework for developing guidelines for the project (Amazon Watch, 2006; Caffrey, 2002). Independent or transparent monitoring methods were not incorporated into the original project plans, which were also deficient of mandating authentic procedures for independent technical and advisory management. These standards fail to meet those of the World Bank, which further exposes the shortcomings of the planning stages of the project (Caffrey, 2002). Due to much public outcry from many environmental and social non-profit and non-governmental local, national and international organizations, for both new policies as well as the necessity for greater inclusion of the public in decision-making, the IDB recently drafted a new environmental policy, but the Board of Directors did not approve it until January 19, 2006, after the initial phase of Camisea was completed ((BIC), 2008). Although subsequent steps have been taken, such as the establishment of an independent monitor, the Camisea project is largely precluded from this new policy (Amazon Watch, 2006).

2.1.2. Environmental Impact Assessment and Enforcement

Two separate Environmental Impact Assessments (EIAs), upstream and downstream, were conducted by consultants hired by Pluspetrol. Critics maintain that these disparate EIAs did not cumulatively consider the effects of the project. An independent EIA, commissioned by civil sector groups, details potential direct and indirect impacts of the project that were not identified in the original EIAs (Caffrey, 2002). Major deficiencies of the official EIAs include neglecting to acknowledge the impact that access roads will have on fragmentation, degradation and deforestation in several locations across the pipeline (Caffrey, 2002). The precautionary principle states that the absence of scientific certainty (which is essentially impossible to attain in many environmental decisions) is not a valid reason not to act preemptively, particularly if the consequences can be irreversible or catastrophic. Due to this reasoning, one of the customary options in an EIA is that of the 'no development', which explicates that one alternative is that no development occurs. Similarly, in these types of projects, there routinely is a 'no-go' zone, in some part of the area is not developed or explored, to preserve its environmental integrity. The EIAs developed and subsequently approved included neither the 'no development' nor the 'no-go' zone alternative, effectively removing these options from the decision-making process, further driving incomplete decision-making (Amazon, 2005; PlusPetrol, 2004).

From the outset, civil sector groups have voiced serious concern about the quality of the construction of the pipeline, and these suspicions have been confirmed: in February of 2006, E-Tech International, an independent engineering consulting firm, published a

comprehensive report expressing serious concern about the substandard construction and a Peruvian Congressional Commission concurred with the report in June 2006 (Herrera Descalzi, 2006). Since the opening of the pipeline in August of 2004, six leaks have been reported, an unprecedented amount for a new pipeline, spilling thousands of gallons of liquid natural gas into the surrounding milieu (IDB, 2008). Moreover, the E-Tech report estimates that currently 190 miles of pipeline are very vulnerable to ruptures in the near future, due to low-quality materials, corrosion, soil instability and substandard welding conducted by unqualified workers (Tirado, 2006).

Increasingly extractive industries face calls for improved sustainability, particularly for strong sustainability. Weak sustainability proffers that each generation “has the moral obligation to keep the total stock of capital at least constant,” where the total stock is a mixture of natural and produced capital stocks (Krysiak, 2006, p.189). Therefore, manufactured capital of equal value can take the place of natural capital. In strong sustainability, however, all forms of capital must be maintained, independent of each other, implying a complementary rather than a surrogate relationship (Özakynak et al., 2004). Considering that there still remain substantial uncertainties in understanding the importance of and relationship between capitals, a comprehensive approach in the extractive, in accord with the precautionary principle, would be to follow the principles of strong sustainability.

Independent enforcement mechanisms, therefore, are vital for ensuring transparency in the strong sustainability process. The Extractive Industries Transparency Initiative (EITI), is one such instrument. In it, governments and foreign firms agree to

make their financial and social operations public (Economist, 2008), enabling outside scrutiny and questioning of the information.

2.2 Project Impacts On Indigenous Peoples

Although economic welfare and poverty alleviation are some of the IDB's mandates for this project, consequences of development have had adverse effects on some of the lives and livelihoods of some of Peru's poorest citizens: its indigenous peoples (Amazon Watch, 2006; Caffrey, 2002; IDB, 2005). This project impacts approximately 11,000 native inhabitants, including 22 indigenous communities (PlusPetrol, 2004). In fact, many sections of the pipeline fall within national reserves such as the Nahua Kugapakori State Reserve and the Manu National Park, areas that were created by the Peruvian government over a decade ago to protect these nomadic and isolated peoples with limited immunity to alien germs and sicknesses. When the Peruvian government approved the operation of the consortium in the Camisea area, they effectively opened the ancestral territories of indigenous communities, lands that are culturally and legally the purview of those communities, to the companies.

Contact between those peoples and construction workers and migrants attracted by the road, caused, in some cases, severe health issues (Amazon Watch, 2005; Caffrey 2002). Workers became involuntary vectors of foreign germs that resulted in substantial amounts of illness. The Peruvian Ministry of Health has acknowledged 22 deaths among the people of the various nomadic and semi-nomadic non-contacted tribes that live within the construction sites (Amazon Watch, 2005; personal interviews, 2005). In addition, the

environmental degradation caused by the project poses a serious threat to their lifestyles. Soil erosion from the construction and pipeline leaks have contaminated water supplies, threatening fish and game populations and triggering chronic malnutrition and other illnesses (Caffrey, 2002; personal interviews, 2005). The quality of life for all those living near the construction sites was also considerably impacted, as the noise of construction machines and helicopters needed for the building of the pipeline created sometimes quite intense cacophony for months on end (Amazon Watch 2005; personal interviews, 2005).

2.2.1 Environmental Impacts

Major ramifications of the project also include significant environmental damage. In order to exploit the gas in the remote Camisea region, access roads were built, opening up previously inaccessible areas of forest. The consortia has claimed a 25 meter right-of-way as part of the project area around the pipeline, making it much more vulnerable to flooding and soil erosion, permanently threatening the delicate balance of the ecosystems. The transportation of the liquid natural gas presents significant risk, as leaks in the pipeline endanger the terrain and could render parts of it permanently damaged or destroyed. Since liquid natural gas must be converted, or fractioned into different parts for usage, a fractioning plant was constructed in the zone of the Paracas National Reserve, Peru's only natural protected area that includes marine habitat, and also home to several endangered species, including the Humboldt Penguin (Schlosser, 2003). The gas will also be exported to the Chile, the United States, Canada and possibly Europe, thus a

distribution plant is currently under construction in Lima (Landers, 2006). These environmental impacts could also affect tourism, an important sector of the Peruvian economy (Amazon Watch, 2006; Landers, 2006).

2.3 Pluspetrol Compensation Program

The IDB has framed the Camisea Project as “making an important contribution to Peru’s economic and social development,” but also acknowledges that damages will be incurred in the process (IDB, 2004). Pluspetrol, as the major overseer of this project, was responsible for coordinating an impact analysis in order to determine a compensation program for the affected communities. In the 2004 report issued by the company, it details the process used to craft the compensation program for communities that were directly and indirectly impacted by the pipeline. An independent consulting firm, Environmental Resources Management (ERM), conducted field research and utilized the aforementioned EIS and a social impact study (SIS) to formulate economic impact studies and compensation programs. These reports were then submitted to the General Bureau of Environmental Affairs (DGAA) of the Ministry of Energy and Mines (MEM), which specified required corrections to the report and mandated that three public hearings be held. The compensation program was subsequently approved by the Peruvian Government (GoP) in December 2001.

The studies began by identifying the areas that would be directly and indirectly impacted by the project, which are comprised of 4 subprojects: 3D geoseismic operations and survey; drilling of production wells from four exploitation platforms; gas and oil

condensate flow lines, from the exploitation platforms to the gas plant; and the gas plant located in the Malvinas locality (owned by Pluspetrol). The upstream projects (as specified by the IDB) include the gas and condensate fields and 3D seismic operations, drilling platforms (together known as Block 88), fractionation plant and export terminal. The downstream project consists of the gas and condensates pipelines (flow lines), and the distribution project includes the natural gas distribution network in Lima and Callao (IDB, 2004). Total land area types and amounts were then determined. This final land area figures include the direct impact of the pipelines, as well as a 25 m right of way, ROW, impact area.

The valuation methodology was then used to:

- 1) Identify what settlement communities were affected by the project, either directly or indirectly, placing emphasis on the characteristics of the people living in those areas
- 2) Determine what specific project activities (e.g. well drilling or river traffic) impact those communities and the magnitude of those activities
- 3) Designate the impact as direct or indirect and positive or negative, local or regional; and determin[e] the reversibility, recoverability, permanence and extent of the impacts, based on the mitigation measures proposed and utilized by Pluspetrol
- 4) Diagnose what environmental factors were affected in those areas of impact,
- 5) Employ a Willingness to Pay (WTP) methodology with members of affected communities to establish values on the environmental factors according to the

degree of impact

(PlusPetrol, 2004)

These areas of influence were analyzed by the following criteria to determine overall direct and indirect impact of the project to the residents of the impacted land, the majority of which are indigenous peoples:

- characteristics of the people living in and the degree of influence of the project operations on these settlements
- the loss of natural resources translated into a reduction and/or elimination of the means of subsistence and production
- reductions in the resources, as well as the displacement of animals to other places caused by activities that disturb the ecology of the native communities
- the loss of quality of life of the inhabitants of native communities
- perturbation caused by the noise of different forms of transport in the working areas
- loss of cultivated land, which implies a reduction in means of production
- the mitigation plans aimed at minimizing ecological risks
- plans to prevent risks arising from natural phenomena and accidents, or those caused by third parties

(Pluspetrol, 2004, pps. 20-22)

The values for the environmental influences were determined by the WTP surveys conducted with the various communities affected, as well as by various studies carried

out by public and private institutions, to reflect the most representative value or values of the group of environmental factors. Table 2-1 illustrates these values.

Group of environmental factors	Value of the Impact (US\$)	Unit of Measurement
1. Geology and morphology	165.93	Ha. / year
2. Soils (VS)	4.45	Ha. / year
3. Atmosphere and air (VAA)	4,120.00	Ha. / year
4. Surface water resources (VRHS)	34.32	Families / year
5. Underground water resources (VRHB)	70.00	Ha. / year
6. Flora (VFLO)	6,330.00	Ha. / year
7. Fauna (VFAU)	1,000.00	Families / year
8. Landscape (VP)	200.00	Tourists / year
9. Population (VPOB)	126.51	Families / year

Table 2-1: Pluspetrol Economic Valuation of Impacts By Groups of Environmental Factors Source: Pluspetrol Report, 2004 (pp. 51)

According to the company, the compensation package also integrated the perceptions and expectations of the native communities, derived through individual community consultation, the communal point of view and prior collective experiences with oil companies. This information was obtained in community meetings conducted by workers from the Sociedad Universo and Naturaleza, a Peruvian non-governmental organization, as well as Pluspetrol personnel. Impact and compensation schemes were formulated in relation to the environmental, social and economic loss of the people that

were directly and indirectly impacted, expressed through the above explicit dollar amounts.

Using the figures above, Pluspetrol provides a sample study for the area for Block 88 to demonstrate the methodology. The company determines that the total land area, both directly and indirectly impacted in Block 88 is 91 969.5 ha, with the total compensation being \$1 753 158.41 (USD in 2004). In total Pluspetrol, with the approval of the IDB, has committed US \$10.2 million total funds for direct and indirect impacts of all of the components of the Camisea Project to different native communities and indigenous federations (IDB, 2005; PlusPetrol, 2004).

3. Ecosystem Goods And Services

The importance and contribution of healthy ecosystems to human well-being and poverty reduction has gained increasing awareness and attention in recent years. Perhaps the most significant example of this is the Millennium Ecosystem Assessment, launched by then U.N. Secretary-General Kofi Annan in June 2001, to provide a global, integrated evaluation of the current changes and consequences occurring within ecosystems. In this 2005 comprehensive assessment ecosystems are defined as “a dynamic complex of plant, animal and microorganism communities and the nonliving environment interacting as a functional unit” (p. V.). The components in ecosystems, such as soil and trees, interact in complex processes that create functions that then lead to environmental goods and services. Ecosystem services, then, are the benefits that people obtain, directly and indirectly, from ecosystems. There are various types of ecosystem services, including

provisioning services, such as food, water and timber; regulating services that influence climate, water quality, floods and diseases; supporting services, including soil formation, photosynthesis and nutrient cycling; and cultural services that provide recreational, spiritual and recreational benefits (MA, 2005). When ecosystems are healthy, they provide these services for free and perpetually.

3.1 Ecosystem Services Valuation Background

Despite the wide-scale acknowledgement that ecosystems are fundamental to Earth's life-support systems and vital to human well-being, the majority of the benefits yielded by ecosystem services are currently exogenous to the economic system, so their value is not equally weighted in decisions that directly impact their functioning and well-being (Costanza et al., 1997a; Stratton, 2006; Turner et al., 2003). Traditional economics generally considers impacts to ecosystems as externalities and often not accounted for in development work. However, in a 1997 seminal work, Costanza et al. argue that ecosystem services should be embodied within the complete economic worth of the Earth, and estimated that 17 ecosystem services for 16 biomes are worth, on average, \$33 trillion annually, most of which is outside the market (Costanza et al., 1997). Since then, the concept of ecosystem services has been debated in many circles, with growing recognition that it increasingly has merit to be considered among a range of options for decision-making processes (MA, 2005; Turner, 2003).

Integral to the ecosystem service valuation approach is the idea that “interactions (of components, processes, and systems with other systems) give[s] rise to complex

behaviors,” (Limberg et al., 2002). This synergistic effect is not easily determined or forecasted, which leads to uncertainty that does not allow for linear predictability. Since this complexity cannot be sufficiently understood, decisions that integrate the potential for the unknown, a component of the precautionary principle, allow for a more complete assessment. Ecosystem services valuation (ESV) attempts to capture the aspects of ecological impact that has previously gone unacknowledged in the same framework as the costs and benefits ascertained in development projects. Successful projects such as the Payment for Ecosystem Services program currently being conducted on a national level in Costa Rica, have placed ESV as a valid and more complete approach to decision-making regarding myriad development, economic and ecological projects, with the basis that human-well being is entirely dependent upon healthy ecosystems, for which there is no absolute substitution (May, 2002; Pagiola, 2002). Although there are criticisms of applying ESV as a direct benefits accrual because there is usually no market for provision of these services, precisely because there is no recognition by the market of the value of ecosystem services it is critical to highlight their value in a comparable way.

There have been significant links to the importance of intact, healthy ecosystems for poverty alleviation, which is also the aim of development work (Turner et al., 2002). Conflict arises, however, when development projects compromise the health of ecosystems, and overall ecosystem wellness is not explicitly included as a decision factor in the process (Amazon, 2005). By failing to recognize the intrinsic value and direct contribution to human well-being of these healthy ecosystems, both now and in the future, decisions about the overall economic benefit of development projects are

incorrectly based, which could lead to substantial losses – fiscally, environmentally and socially. Having to retroactively address problems caused or exacerbated by these development projects is incongruent with the initial mission of development work. While traditional development projects often include some type of compensation scheme, these are usually quite reduced in scope, only addressing direct damage or impacts that might be incurred on a specific environmental good, without incorporating the larger ecosystem and their services to perform a systems-based analysis (Turner et al., 2002).

3.1.1 Ecosystem Services Valuation Methodology Overview

There are varying methods to perform ecosystem services valuation, with each producing unique outcomes. Although users acknowledge the limitations of the methodologies and ad hoc valuation tactics in capturing precise values of the contribution of ecosystems to human well-being, they advocate the general approach as it allows for ecosystem worth to be translated into a language that garners equal weight to those services provided by human structures. Examples of valuation methods include hedonic pricing, which reflects what people are willing to pay for services through prices (ie. housing prices are higher on the coast than they are for the same house inland); contingent valuation, the use of hypothetical situations to derive prices for various land use options; and group valuation, a discourse-based contingent valuation with stakeholders. Although there has been debate about the appropriateness of putting the contributions of ecosystem services within the market framework - which could lead to privatization, rivalness, and exclusion - ecosystem services valuation has emerged as a

very effective technique for providing a more level playing field with other compensation approaches. By using an understandable, market-based structure, ESV can be used to underscore the importance of ecosystems and their very real contributions.

Much of the ESV discussion that attempts to move its methodology towards creating more standard approaches is an ontological one that consists of identifying distinctions between ecosystem structures, functions, processes, components, goods and services. Given the complexity of ecosystem structures and functioning, delineating the relationships between them is a good starting point for a comprehensive assessment of the services provided. De Groot et al. (2002) propose a taxonomical system that starts with ecosystem structure and processes: the result of multifaceted interactions between the living (biotic) and the chemical and physical (abiotic) parts of ecosystems. The ecosystem structures are organized quantities of matter in time, while the processes are the changes in organized matter over time. Ecosystems functions are subset clusters of structures and processes, which are recognized to provide goods and services that serve human requirements. Ecosystem services are ecosystem processes placed within their socio-cultural and economic importance, while ecosystem goods are the structures placed within the same context. ESV can monitor both goods and services (De Groot et al., 2002).

3.1.2 Rapid Assessment Valuation

The discussion above illuminates that there are numerous methods to conduct ecosystem services valuation. While it is ideal to be free of financial and temporal

constraints to conduct an in-depth, long-term ESV investigation, this is often outside the reality of projects such as this one. Timely and reliable evaluations about ecosystems must be made in order to be able to be considered with more traditional data sources. Rapid assessment valuation (RAV), which employs a framework of standard land use area types and biomes into which specifics of the study area can be plugged in, can be used as an ESV methodology that accounts for fiscal and time constraints. In place of not having any information on ecosystem services, RAV offers a standardized method to provide critical information for more comprehensive decision-making.

Rapid assessment methods have been successfully utilized for decision-making in other arenas, such as wetlands biodiversity. Rapid assessment has been recognized by the international Ramsar Convention on Wetlands as a tool for providing prompt and dependable data for decision-making (Ramsar, 2005). In fact, the Millennium Assessment states that rapid assessment is essential to monitoring ecological quality, ecosystem resilience and capability of services and the need to develop assessment and valuation methods is critical (Carpenter, 2006).

This study employs what is intended to emerge as a standard methodology for rapid assessment valuation. It provides a structure that would optimally be used to incorporate local and indigenous knowledge in the valuation process while it is based on agreed-upon values in the relevant literature, giving it scientific rigor. By using local knowledge in conjunction with expert baselines, this assessment can be conducted in a reasonable time frame. Therefore, RAV allows for thorough, inclusive and swift appraisal for cases that face real deadlines and fiscal limitations.

Costanza et al. (1997) and de Groot et al. (2002) provide a framework in which ecosystem services are considered through four main functions: regulation, habitat, production and information. Examples of regulation functions include the process of biota to disseminate floral gametes, pollinate crops and contribute to the production of food (de Groot et al., 2002). The goods and services benefits (value) of the pollination function could be derived from market prices illustrating human needs for food. Socio-cultural and economic values are space and time specific and relate to the sustainability of the functions and their socio-economic context. See Howarth and Farber, 2002; Farber et al., 2002; Limburg et al., 2002 and Wilson and Howarth, 2002 for further discussion of these concepts. Economic values represent an economic context, which can be measured through various methods, including direct market, indirect market, contingent and group valuation processes (DeGroot et al., 2002). For our template we use the updated figures and ecosystem services that DeGroot et al. derived from the Costanza et al. synthesis study (1997) that reviewed more than 100 studies, and added one ecosystem service, navigational services. Through this we establish a range of values (minimum and maximum) for each function and associated goods and services. It is possible to update these values through the Ecosystem Services Database, which occasionally revisits ecosystem services values (<http://esd.uvm.edu/>).

In this template land use types to be assessed are identified as: forests, grasslands and shrubs, agriculture and pasture, urban, lakes, rivers, ponds and reservoirs, wetlands, coastal, desert or rock, synthesizing the 13 land uses Costanza et al. (1997) specify. As need dictates, these can be further expanded (ie. from forest to tropical forest) and the

appropriate figures incorporated. Twenty-three ecosystem services are designated to describe their contributions to each of the land use types. To determine the actual services being provided by these ecosystem in each land use area (LU) for a specific area, both an optimum health or condition of these biomes (called ideal health) as well as their actual health or condition (called actual health) must be determined by assigning a ratio between 0 and 1 in both health categories. This model provides baselines for the ideal health conditions based on current literature. A value of 1 in the ideal health estimate would indicate perfect health and no disturbance in the functioning and performance of the ecosystems given the type and amount present in that area. For example, our ideal health figures for forests are assigned all 1s (aside from food), as perfectly healthy forests provide optimum ecosystem services.

Determining the actual health index of a specific area can be accomplished by various methods, such as using GIS data, or through a participatory process in which local stakeholders provide their expertise of the area. The actual health condition of the area is based on the ecosystem disturbances, determined through available data and on-site assessments of the present condition. The ideal and actual health values are multiplied to derive the overall health estimate figure. Minimum and maximum dollar values per hectare for ecosystem functions for the biomes are derived from values in the template. To estimate a range of values, the minimum value is multiplied by the overall health figure, which is then multiplied by the land use area to obtain a minimum dollar value per hectare. This is also done with the maximum value to determine the range of

values for the ecosystem services. Table 2-2 presents the ideal health template. Table 2-3 demonstrates the minimum and maximum default values.

In the absence of, or as an accompaniment to, technical data such as GIS, this template provides the space for participatory methods that include local and indigenous communities to ascertain the land use and actual health figures. These actors have the greatest in-depth understanding and historical relationship with the land and therefore possess invaluable knowledge that would most appropriately drive the valuation process. Thus, the advantage of this method is that it foments the use of local (and potentially the most accurate) knowledge by encouraging stakeholder participation in the valuation process. This corresponds well with the Millennium Assessment's local adaptations of the conceptual framework, that recognizes the needs and concerns of local communities vary and input should be obtained as much as possibility to most accurately reflect specific situations (Alliance, 2004).

	Forest	Grasslands and Shrubs	Agriculture and Pasture	Urban	Lakes, Ponds, Rivers and Reservoirs
Gas Regulation	1.00	0.75	0.35	0.00	0.00
Climate Regulation	1.00	0.60	0.35	0.02	0.00
Disturbance Prevention	1.00	0.90	0.35	0.00	0.00
Water Regulation	1.00	0.85	0.65	0.02	0.00
Water Supply	1.00	0.80	0.35	0.14	0.00
Soil Retention	1.00	0.90	0.50	0.16	0.00
Soil Formation	1.00	1.00	0.60	0.02	0.00
Nutrient Regulation	1.00	0.75	0.35	0.04	0.00
Waste Treatment	1.00	0.90	0.35	0.18	0.00
Pollination	1.00	0.75	0.25	0.30	0.00
Biological Control	1.00	0.60	0.35	0.18	0.00
Refugium Function	1.00	0.65	0.30	0.16	0.25
Nursery Function	1.00	0.55	0.30	0.18	0.05
Food	0.30	0.35	0.65	0.02	0.00

Raw Materials	1.00	0.25	0.75	0.00	0.75
Genetic Resources	1.00	0.25	0.00	0.00	0.00
Medical Resources	1.00	0.00	0.00	0.00	0.00
Ornamental Resources	1.00	0.00	0.00	0.00	1.00
Aesthetic Information	1.00	1.00	0.50	0.36	0.50
Recreation	1.00	1.00	0.00	0.44	0.10
Cultural and Artistic Information	1.00	1.00	0.20	0.60	0.10
Spiritual and Historic Information	1.00	0.50	0.50	0.54	0.25
Science and Education	1.00	0.65	0.75	0.60	1.00
Navigational Services	1.00	0.00	0.00	0.00	1.00

Table 2-2: Ideal Land Use Default Figures

Ecosystem Service	Default values	
	Min	Max
Gas Regulation	\$100.00	\$265.00
Climate Regulation	\$88.00	\$223.00
Disturbance Prevention	\$1000.00	\$7,240.00
Water Regulation	\$1000.00	\$5,445.00
Water Supply	\$1000.00	\$7,600.00
Soil Retention	\$50.00	\$245.00
Soil Formation	\$1.00	\$10.00
Nutrient Regulation	\$87.00	\$21,100.00
Waste Treatment	\$58.00	\$6,696.00
Pollination	\$14.00	\$25.00
Biological Control	\$2.00	\$78.00
Refugium Function	\$500.00	\$1,523.00
Nursery Function	\$142.00	\$195.00
Food	\$1000.00	\$2,761.00
Raw Materials	\$500.00	\$1,014.00
Genetic Resources	\$100.00	\$112.00
Medical Resources	\$500.00	\$2,000.00
Ornamental Resources	\$3.00	\$145.00
Aesthetic Information	\$7.00	\$1,760.00

Table 2-3: Default Values for Ecosystem Services

4. Rapid Assessment Valuation In The Camisea Project - Methodology

To get a comprehensive understanding of the overall impact of the pipeline for the ESV, the various components of the project and both the direct and indirect areas of impact were determined. Although as mentioned above while PlusPetrol identified a 25 m ROW, the IDB suggests setting the spatial range for the direct area of influence at 3 km (IDB, 2005). The ESV area for the indirect, long-term impact encompasses a 100 km corridor around the pipeline, a figure attained from the 3 km direct area of influence, as well as an additional area that could be affected over the long-term, accounting for things such as spills, deforestation, colonization, etc., to best allow for comparison with those areas in the Pluspetrol report. Table 2-4 exhibits the types and sizes of these areas.

An initial baseline was established by imputing figures for before-project conditions into the RAV template. Some of the actual health estimates are quite high, particularly the categories of forest (.97) and lakes, rivers, ponds and reservoirs (.96), reflecting the relatively pristine condition of the land prior to this project. Although the IDB reports that there were some previously damaged areas due to oil exploitation in the region in the 1980s, the fact that these areas are designated as biodiversity hotspots, as well as the information gleaned through personal interviews attest to the fact that these areas were fully functioning and providing important ecosystem services (Amazon Watch, 2005; IDB, 2005; personal interviews, 2004). In fact, according to Caffrey (2002), 90% of the area of Block 88 is primary forest in a pristine state of conservation (2002).

COMPONENT	COMPONENT SUBPROJECTS	LOCATION	LAND TYPE(S)	TOTAL LAND AREA – PLUSPETROL	TOAL LAND AREA – RAV
UPSTREAM					
Gas and Condensate Fields	Exploitation Fields	Amazonian rainforest of the Lower Urubamba region	Forestry and agriculture Mainly undeveloped with sparse settlement	1200 km ² (120,000 ha)	1200 km ² (120,000 ha)
3D Seismic Survey and Exploitation Area (Block 88)	Heliports, campsites and unloading zones Blasting and registry lines			~800 km ²	32 ha 749 ha
Malvinas Locality and Processing Plant	Well platforms and facilities - 4 platforms of 2 ha each			8 ha	8 ha
	Malivinas Locality - processing plant and corresponding facilities			2300 ha (buffer zone) 30 ha (plant and facilities)	2,000 ha (buffer zone) 72 ha (plant and facilities + area of influence)
	Flow lines to Malvinas Processing Plant			64.45 km	161 ha (64.45 km*25m ROW)
Fractionation Plant	Processes gas liquids into individual gas liquids	Paracas Bay, south of Pisco	Coastal plain and ocean in the buffer zone of Paracas National Marine Reserve	43.7 ha + 3 km jetty	43.7 ha + 3 km jetty
DOWNSTREAM					
Gas and Condensates Pipelines	Pipeline + Right of Way ROW – 25 m wide along length of pipeline	Malvinas to Pisco	Rainforest Amazonian rainforest in Urubamba River Valley (biodiversity hotspot)	Pipeline totals: ~697 km (* 25 m ROW) natural gas pipeline from Malvinas to City Gate of Lima = 17.425 km ²	182 km * 100 km corridor = 18,200 km ²
			Highlands Andean foothills, plateau and mid-	~575 km (*25 m)	62 km + (foothills) 95 km + (plateau) +

			Andean valleys; rugged mountainous areas	liquid natural gas pipeline from Malvinas to Pampa Clarita =	116 km (mountains) * 100 km = 273,000 km ²
			Coastal Plains Agricultural, urban, public and private	14.375 km ²	95 km * 100 km = 9500 km ²
			Coastal Desert Dry and irrigated farmland		165 km * 100 km = 16,500 km ²
			Urban Coastal Areas	60 km * 100 m corridor of direct influence = 6 km ²	60 km * 100 m = 6 km ²
DISTRUTION Distribution Pipeline	Pipeline + Corridor of 'Direct' Influence of High Pressure Distribution	Pisco to Lima			

Table 2-4: Description of PlusPetrol Designations Compared to RAV for Project Components and Their Land Areas

For comparison purposes the same land use types as identified by PlusPetro were used, adapting from the LU areas in the template: tropical rainforest, Andean foothills, Andean plateau, Andean mountain, coastal plain, coastal desert. Land use areas are determined by the user with site-specific data, so they will differ from the template. Once the LUs are established, they can be translated into biomes. Ideally there will be an agreed-upon full-fledged ontology to cover all LUS types and their abilities to provide ecosystems, but that ontology does not exist and therefore we take this short cut. The biomes for these areas were determined and translated each LU type into hectares. These values were compared to the values obtained by Pluspetrol to have a more equally balanced assessment of the project. Table 2-5 demonstrates the pre-project, baseline values obtained from RAV (all amounts in US dollars). It does not list the values for several areas classified due to space issues. The total values for the pre-project conditions range from \$21 942 422 098 to \$205 599 948 331 annually. Some of the figures obtained may seem high, but the largest portion of the land considered impacted (~1 823 265.8 ha) is in critical pristine tropical rainforest, thus these figures attempt to reflect the importance of the services that this biome provides.

Two scenarios were then developed to provide ranges of values for ecosystem service impact. A short-term direct impact scenario, with the timeframe of 1-2 years, attempts to capture development and construction impacts, including the 3 km corridor ROW. The second scenario is for the long-term and indirect impact, which includes the 100 km corridor of impact over a 25-year timeframe, to capture long-term impacts that include direct impacts beyond only the construction impacts. Note that this area is

significantly larger than the Block 88 area defined by PlusPetrol but more accurately reflects the true impact of the pipeline. Considering the pipeline has ruptured five times in the past two years, this figure allows for a comprehensive estimate of true damage of the project. The figures increase over the long-term to take into account restoration processes that can offset the short-term impacts of the project. Table 2-6 shows some of the values of the indirect long-term scenario. The total range of values for the indirect long-term scenario are: 13 003 905 507 minimum and 121 476 095 066 maximum.

	Forest		Grasslands and Shrublands		Agriculture and Pasture	
	Min	Max	Min	Max	Min	Max
Gas Regulation	252,515,600	669,166,340	14,250,000	37,762,500	66,000,000	174,900,000
Climate regulation	222,213,728	563,109,788	12,540,000	31,777,500	58,080,000	147,180,000
Disturbance Prevention	2,525,156,000	18,282,129,440	213,750,000	1,547,550,000	330,000,000	2,389,200,000
Water Regulation	2,525,156,000	13,749,474,420	142,500,000	775,912,500	330,000,000	1,796,850,000
Water Supply	2,525,156,000	19,191,185,600	142,500,000	1,083,000,000	330,000,000	2,508,000,000
Soil Retention	126,257,800	618,663,220	10,687,500	52,368,750	33,000,000	161,700,000
Soil Formation	2,525,156	25,251,560	213,750	2,137,500	330,000	3,300,000
Nutrient Regulation	219,688,572	53,280,791,600	18,596,250	4,510,125,000	28,710,000	6,963,000,000
Waste treatment	146,459,048	16,908,444,576	12,397,500	1,431,270,000	19,140,000	2,209,680,000
Pollination	35,352,184	63,128,900	2,992,500	5,343,750	9,240,000	16,500,000
Biological Control	5,050,312	196,962,168	427,500	16,672,500	660,000	25,740,000
Refugium function	1,262,578,000	3,845,812,588	71,250,000	217,027,500	165,000,000	502,590,000
Nursery function	358,572,152	492,405,420	20,235,000	27,787,500	46,860,000	64,350,000
Food	2,525,156,000	6,971,955,716	142,500,000	393,442,500	1,320,000,000	3,644,520,000
Raw	1,262,578,000	2,560,508,184	35,625,000	72,247,500	330,000,000	669,240,000

Materials						
Genetic resources	252,515,600	282,817,472	7,125,000	7,980,000	0	0
Medical resources	1,262,578,000	5,050,312,000	0	0	0	0
Ornamental resources	7,575,468	366,147,620	0	0	0	0
Aesthetic Information	17,676,092	4,444,274,560	1,496,250	376,200,000	2,310,000	580,800,000
Recreation	1,262,578	631,289,000	142,500	71,250,000	0	0
Cultural and Artistic Information	252,515,600	2,525,156,000	28,500,000	285,000,000	26,400,000	264,000,000
Spiritual and Historic Information	2,525,156	63,128,900	142,500	3,562,500	330,000	8,250,000
Science and Education	2,525,156	63,128,900	71,250	1,781,250	330,000	8,250,000
Navigational services	2,525,156	12,625,780	0	0	0	0
Total Min	15,796,113,358		877,942,500		3,096,390,000	
Total Max		150,857,869,752		10,950,198,750		22,138,050,000

Table 2-5: Baseline Values for Ecosystem Services for the Before Pipeline Scenario

	Forest		Grasslands and Shrublands		Agriculture and Pasture	
	Min	Max	Min	Max	Min	Max
Gas Regulation	145,000,000	384,250,000	11,000,000	29,150,000	45,250,000	119,912,500
Climate regulation	127,600,000	323,350,000	9,680,000	24,530,000	39,820,000	100,907,500
Disturbance Prevention	1,450,000,000	10,498,000,000	165,000,000	1,194,600,000	226,250,000	1,638,050,000
Water Regulation	1,450,000,000	7,895,250,000	110,000,000	598,950,000	226,250,000	1,231,931,250
Water Supply	1,450,000,000	11,020,000,000	110,000,000	836,000,000	226,250,000	1,719,500,000
Soil Retention	72,500,000	355,250,000	8,250,000	40,425,000	22,625,000	110,862,500
Soil Formation	1,450,000	14,500,000	165,000	1,650,000	226,250	2,262,500
Nutrient Regulation	126,150,000	30,595,000,000	14,355,000	3,481,500,000	19,683,750	4,773,875,000
Waste treatment	84,100,000	9,709,200,000	9,570,000	1,104,840,000	13,122,500	1,514,970,000
Pollination	20,300,000	36,250,000	2,310,000	4,125,000	6,335,000	11,312,500
Biological Control	2,900,000	113,100,000	330,000	12,870,000	452,500	17,647,500
Refugium function	725,000,000	2,208,350,000	55,000,000	167,530,000	113,125,000	344,578,750
Nursery function	205,900,000	282,750,000	15,620,000	21,450,000	32,127,500	44,118,750
Food	1,450,000,000	4,003,450,000	110,000,000	303,710,000	905,000,000	2,498,705,000

Raw Materials	725,000,000	1,470,300,000	27,500,000	55,770,000	226,250,000	458,835,000
Genetic resources	145,000,000	162,400,000	5,500,000	6,160,000	0	0
Medical resources	725,000,000	2,900,000,000	0	0	0	0
Ornamental resources	4,350,000	210,250,000	0	0	0	0
Aesthetic Information	10,150,000	2,552,000,000	1,155,000	290,400,000	1,583,750	398,200,000
Recreation	725,000	362,500,000	110,000	55,000,000	0	0
Cultural and artistic Information	145,000,000	1,450,000,000	22,000,000	220,000,000	18,100,000	181,000,000
Spiritual and Historic Information	1,450,000	36,250,000	110,000	2,750,000	226,250	5,656,250
Science and Education	1,450,000	36,250,000	55,000	1,375,000	226,250	5,656,250
Navigationa l Services	1,450,000	7,250,000	0	0	0	0
Total Max	9,070,475,000		677,710,000		2,122,903,750	
Total Min	0	86,625,900,000	0	8,452,785,000		15,177,981,250

Table 2-6: Values for Ecosystem Services in the Indirect, Long-term Impacts Scenario

4.1 Rapid Assessment Valuation Results

Employing a methodology that includes ecosystem services valuation derives vastly different values than those of Pluspetrol's. Using conservative figures, it was estimated that ecosystem services were devalued from a range of approximately \$22 to \$199 billion in the short term, to approximately \$8 to 84 billion in the long term. The total project cost is estimated at \$1.6 billion and expected to generate \$4.8 billion cumulatively over the 40-year life of the project. The range of values and their losses are demonstrated in table 2-7.

Scen ario	Before: Baseline Conditions	After: Short-term Direct	Loss	After: Long-Term + Indirect	Loss
Min	21,942,422	657,387,941	21,285,034,157	13,002,905,50	8,939,516,59
US \$,098			7	1
Max	205,599,94	6,159,309,	199,440,638,68	121,476,095,	84,123,853,
US \$	8,331	649	2	066	265

Table 2-7: Ranges of Values for Ecosystem Service Valuation Scenario

Although these methods may not allow for rigid direct comparison, entering ESV into the discussion provides a systems-approach to recognizing the benefits and costs of this project. The range of values determined by ESV illuminate the fact that overall the project may be more costly, due to potential impacts of spills, deforestation and new settlements than beneficial to Peruvian citizens. Restoration, mitigation and other unforeseen costs due to damages incurred upon the ecosystems must be considered in order to properly evaluate the efficacy of the project. Examining the ESV figures

elucidates the fact that other opportunities for energy sources in this region, such as renewable energies, should have been explored.

5. Discussion

At the core of the ecosystem service valuation tactic is the concept of systems-thinking. Systems-thinking recognizes that complex systems (particularly ecosystems) are multifaceted and dynamic, and require a wide-ranging understanding of the functioning of and between systems. Often this comprehension can only truly be achieved collaboratively, as it is difficult for one person to possess thorough understanding of such complex, dynamic and adaptive systems. Thus, understanding ecosystem services and their potential values are often collective efforts among a diverse group of stakeholders, as evidenced with the Millennium Assessment, which gathered hundreds of experts from across the globe over several years to accomplish such a wide-ranging endeavor. Just as ecosystems are shared resources that serve all human well-being, decisions that affect their functioning are most appropriately reached through group processes.

If a systems-approach had been taken in both the development stages as well as the continued management and expansion aspects of this project, a different course could have emerged, starting with an ecosystem service valuation of the project. Allowing for public participation in the ecosystem service valuation provides the space of recognizing that ecosystems are shared resources and universally beneficial to humans. Decisions for these shared resources, therefore, should be shared among a diverse group of stakeholders. Indeed, the IDB acknowledges that all residents of Peru are going to be

affected by this project, if in no other way in that it will provide inexpensive energy to many Peruvians (IDB, 2004). However, the method of economic valuation conducted by Pluspetrol did not allow for a legitimate democratization of choices involving resource allocation, as well as the subsequent actions of the IDB and other members of the consortia.

The economic valuation process conducted by Pluspetrol does not adequately evaluate the potential risks and ramifications of risk in this project. To date there have been six spills in the pipeline, an unprecedented amount for such a young pipeline. Both Pluspetrol and the IDB admit that there irreversible damage will occur from this project, but these ruptures were not accounted for in EIAs or the compensation program (PlusPetrol, 2004). In fact, the responses by TGP, the pipeline company, about the spills have been criticized for not being forthright with the communities and minimizing actual incurred damage (personal interviews, 2004; Stein, 2005). The lack of acknowledgement in the planning stages of the possibility of such incidents nor providing the opportunity for stakeholder input on how these situations should be handled should they arise, again denied inclusion to the parties who are most affected by these occurrences and augments the disparity between involved parties.

Additionally, there has been issue with the fact that Pluspetrol and other members of the consortia have not dealt with the communities as an organized body, but would only deal with one community at a time (Caffrey, 2002; personal interviews). This isolation can lead to disenfranchisement and thwarts the opportunity for collective empowerment or for greater bargaining leverage. Moreover, the individual companies in

the consortia dealt with communities, instead of arranging themselves in one body or organized unit, which can create confusion and uncertainty in the communities, particularly if divergent or opposing information is presented. True participatory methods would allow for an open dialogue and encourage group and individual input in the process.

5.1 Conclusions And Recommendations

Given the likelihood that there will be further exploitation of the gas reserves in Peru and throughout the Amazon - currently there is at least one area, Lot 56, located near the same area as the original Camisea project under consideration for development - understanding the failures of this project can shed important insight on how to avoid such outcomes in future projects. Recognition of the possibility of different development trajectories could lead to alternative, and potentially more beneficial, outcomes.

An ecological economic approach to projects that involve land use change, such as the Camisea project, provides for a more systems-based approach to determining true impact. Using this lens in decision-making employs the precautionary principle and develops a full range of alternatives, including not proceeding with the project, to gain a true comprehension of the potential risks and benefits of any project. It provides the space to acknowledge the possibility of accidents and allows for crisis response development (e.g. pipeline ruptures) and allows for the promotion of strong sustainability. An ecological economic approach would also encourage the consortia and

the IDB to sign the Extractive Industry Transparency Initiative, to further promote transparency and accountability.

It also utilizes ecosystem services valuation to illuminate traditionally ignored impacts to natural systems. The rapid assessment valuation template introduced above enables ESV to be performed for projects with limited time and resources. RAV engenders the inclusion of indigenous and/or local knowledge for information transfer to facilitate genuine understanding of the project area, including the direct impacts of the project, as well as how the health of these systems will be impacted by indirect and long-term influences. Furthermore, this lens provides a framework to generate transparency in every step of the process and establishes accountability mechanisms to ensure compliance with project agreements.

References

- Alterman, R., 1982. Planning for public participation: the design of implementable strategies. *Environment and Planning*. 9, 295-313.
- Amazon Alliance, 2004, The Camisea Project. Accessed October – December 10, 2007, from <http://amazonalliance.org/camisea.html>.
- Amazon Watch, 2006. Camisea Natural Gas Project. Accessed on January 30, 2008. <http://amazonwatch.org/amazon/PE/camisea/>.
- Bank Information Center (BIC). 2008. Environmental Policy at the IDB. Accessed on February 15, 2008. <http://www.bicusa.org/en/Issue.35.aspx>.
- Beirele, T.C., Cayford, J., 2002. *Democracy in Practice: Public Participation in Environmental Decision*. Resources for the Future Press, Washington, DC.
- Caffrey, P.B., 2002. *An Independent and Social Assessment of the Camisea Gas Project*. Bank Information Center.
- Carpenter, S.R., DeFries, R., Dietz, T., Mooney, H.A., Polasky, S., Reid, W.V., Scholes, R.J., 2006. Millennium ecosystem assessment: research needs. *Science*. 314, 257-258.
- Cincotta, R.P., Wisnewski, J. and Engelman, R., 2000. Human population in the biodiversity hotspots. *Nature*, 404(6781), 990-992.
- Conservation International, (CI) 2007. Biodiversity hotspots: tropical Andes. Accessed on February 1, 2008. <http://www.biodiversityhotspots.org/xp/hotspots/andes/Pages/default.aspx>
- Costanza, R., Cumberland, J., Daly, H., Goodland, R., and Norgaard, R., 1997a. *An Introduction to Ecological Economics*. St. Lucie Press, Boca Raton, FL.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997b. The value of the world's ecosystem services and natural capital. *Nature*. 387, 253-260.
- Daly, H.E. and Farley, J., 2004. *Ecological Economics: Principles and Applications*. Island Press, Washington, DC.

de Groot, R. S., Wilson, M.A, Boumans, R.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*. 41(3), 393-408.

Economist, 2008. There is hope. *The Economist* 389(8601), 1.

Economist, 2005. Are you being served? *The Economist*. 375(8423), 1.

Energy Information Administration, EIA, 2006a. Annual energy review.

Energy Information Administration, EIA, 2006b. Peru.

Farber, S. C., Costanza, R., and Wilson, M.A. , 2002. Economic and Ecological Concepts for Valuing Ecosystem Services. *Ecological Economics*. 41, 375-392.

Foster, J. and Gough, S., 2005. *Learning, Natural Capital and Sustainable Development : Options for an Uncertain World*. Routledge, London, New York.

Government of Peru (GoP), 2005. Constitution of Peru.

Herrera Descalzi, C.F., 2006. Assessment on the Camisea Pipeline Project in Peru, Committee on Foreign Relations. United States Senate, pp. 11.

Howarth, R. B. and Farber, S., 2002. Accounting for the value of ecosystem services. *Ecological Economics* 41(3), 421-429.

Inter-American Development Bank (IDB), 2005. Camisea Project Overview.

Kasemir, B., Jager, J., Jaeger, C.C., Gardner, M.T., 2003. *Public Participation in Sustainability Science*. Cambridge University Press, England.

Landers, J., 2006. Hunt Oil making big play in Peru: But liquid natural gas faces series of questions. *The Dallas Morning News*, Dallas, TX.

Limburg, K. E., O'Neill, R. V., Costanza, R., Farber, S., 2002. Complex systems and valuation. *Ecological Economics*. 41(3), 409-420.

May, P. H., Neto, F.V., Denardin, V. and Loureiro, W., 2002. Using fiscal instruments to encourage conservation: municipal responses to the 'ecological' value-added tax in Parana and Minas Gerais, Brazil, in: Pagiola, S., Bishop, J. and Landel-Mills, N. (Eds.), *Selling Forest Environmental Services*. Earthscan Publications Limited, London; Sterling, VA, pp. 173-99.

Millennium Ecosystem Assessment (MA), 2005. Ecosystems and human well-being: synthesis. Island Press, Washington, D.C.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*. 403(6772), 853-859.

Özakynak, B., Devine, P. and Rigby, D., 2004. Operationalising Strong Sustainability: Definitions, Methodologies and Outcomes. *Environmental Values*, 13(3): 279-303.

Pagiola, S., 2002. Paying for water services in Central America: learning from Costa Rica, in: Pagiola, S., Bishop, J. and Landel-Mills, N. (Eds.), *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. Earthscan Publications, Limited, London; Sterling, VA, pp. 36-60.

PlusPetrol, 2004. Compensation Program for the Native Communities of Block 88, PlusPetrol Peru Corporation.

Ramsar, Secretariat Convention, 2005. Resolution IX.1 Annex E i on rapid assessment of wetland biodiversity.

Schlosser, J.A., Garner, T.W.J., Dubach, J.M., McElligott, A.G., 2003. Characterization of microsatellite loci in Humboldt penguin (*Spheniscus humboldti*) and cross-amplification in other penguin species. *Molecular Ecology Notes*. 3(1), 62-64.

Smithsonian, 2007. Monitoring and Assessment of Biodiversity.

Straton, A., 2006. A complex systems approach to the value of ecological resources. *Ecological Economics*. 56(3), 402-411.

Tirado, C.S., 2006. E-Tech International: Evaluation of Camisea Project Piping Failures and Long-Term Solutions, E-Tech International.

Turner, R.K. Paavola, J., Cooper, P., Farber, S., Jessamy, V., Georgiou, S., 2003. Valuing nature: lessons learned and future research directions. *Ecological Economics*. 46(3), 493-510.

United States Agency of International Development (USAID), 2004. Multilateral development bank assistance proposals: likely to have adverse impacts on the environment, natural resources, public health and indigenous people.

CHAPTER 3: A DECADE OF PES: BUILDING ON COSTA RICA'S MODEL AND APPLYING LESSONS LEARNED²

Chapter Summary

Costa Rica has pioneered a nation-wide payments for environmental services (PES) scheme that addresses the critical role of private property land use in the provision of ecosystem services. The scheme complements the country's lauded national park system, effectively matching it in area. We describe the origin and functioning of Costa Rica's PES. We then explore a decade of national-level empirical trends (1997-2006) which demonstrate both achievements and challenges. Costa Rica's experience highlights the real-world hurdles of PES implementation and may prove instructive to emerging and future PES schemes. Institutional-design tradeoffs entail striking a balance between efficiency versus equity in participation, production versus conservation modalities, and optimal provisioning of ecosystem services versus achievement of socioeconomic objectives. We suggest several design-enhancements for Costa Rica's scheme. These include decoupling the finance of PES monitoring from the monitoring itself; strategically targeting PES land for both ecological and social objectives; reverse auctioning PES contracts to enhance efficiency and laddering contracts over different time spans to enhance ecosystem service continuity. The long term viability and credibility of PES as a policy tool hinges on learning from the experience of existing programs and on continual innovation. Costa Rica is well-positioned to begin pilot testing some of these nuanced PES design elements.

² Written with Amy E. Daniels, Kenneth Bagstad, Azur Moulart, Carlos Manuel Rodriguez and Olman Segura-Bonilla

1. Introduction

While certainly not the only approach to conserving and managing ecosystem services, payments for ecosystem services (PES) is the first conservation mechanism explicitly designed to address these positive externalities. Variants of PES have existed since at least 1985 when the U.S. Conservation Reserve Program began purchasing long-term cropland retirement on U.S. farms (Szentandrasi et al., 1995). This voluntary program retires agricultural production in exchange for several ecosystem services including soil erosion reduction, habitat provision, and improved water quality. In the developing world, Costa Rica is not only a PES pioneer, but has successfully implemented the only nationwide program to-date.

Over the last decade, PES in Costa Rica and elsewhere has evolved into a more-formalized approach to manage and sustain ecosystem services. PES-based conservation efforts have proliferated in the developing world, and are being actively promoted by international aid and conservation organizations. PES goals may include both ecological objectives, like biodiversity conservation (Pagiola et al., 2005a), and social benefits like poverty alleviation (Pagiola et al., 2005b) and enhanced land tenure security (Grieg-Gran et al., 2005). As with any conservation mechanism, Costa Rica's experience illustrates that PES entails navigating a complex array of program-design tradeoffs. As PES institutions continue developing, it is important to clearly define and evaluate PES in light of specific program goals to ensure they achieve their intended objectives (Mulder and Coppolillo, 2005). Indeed, the long-term viability and credibility of PES as a policy tool hinges on learning from Costa Rica's experience and leadership in the field.

PES schemes present many complex institutional and political design challenges due to the broad array of issues that must be addressed and the logistics of dealing with many stakeholders. An extensive literature exists on Costa Rica's PES (Chomitz et al., 1999; Landell-Mills and Porras, 2002; Rojas and Aylward, 2003; Zbinden and Lee, 2005; Miranda et al., 2006; Pagiola, 2006; Sierra and Russman, 2006; Wunder, 2005; Wunder, 2007). Our goal is to complement this body of literature by reflecting on empirical trends from 1997 to 2006. Costa Rica's PES system is currently gearing up to implement a suite of innovations and enhancements after reflecting on the first World Bank/GEF-affiliated project, Ecomarkets (World Bank 2000). This new phase represents a second round of collaboration between Costa Rica and World Bank/GEF with the goal of mainstreaming and scaling up PES through focusing on identifying and refining sustainable funding mechanisms. Our review dovetails nicely with this initiative.

Details of Costa Rica's PES scheme have not always been consistent or well-documented in the literature, likely due to the evolving legal structure of the program along with divergence between the written laws and their effective regional implementation. Our objectives are to accurately describe PES design and implementation and discuss themes that are critical to the enhancement and continued evolution of the system. In section 2, we describe the origin and operations of Costa Rica's PES, and present national-level data to illuminate trends, achievements and tradeoffs. In section 3, we analyze several themes critical to PES systems. Costanza and Farley (in prep.) further discuss the importance of these themes to successful PES programs: institutional design based on program administration and opportunity costs;

ecosystem service bundling and payment levels; program financing and equity; spatial considerations for PES implementation; and finally, tradeoffs in PES systems relevant to socioeconomic objectives. Some of the challenges we identify are unique to Costa Rica; others apply to PES programs more broadly. Both theory and experiences from elsewhere offer meaningful insight for enhancing Costa Rica's PES design, while programs around the globe stand to learn much from Costa Rica's experience.

2. History and trends in Costa Rica's PES program

2.1 PES Evolution & Scheme Design

Though currently well-known for its conservation programs, in the recent past Costa Rica had one of the highest deforestation rates in the world; between 1986 and 1991 Costa Rica was losing 4.2% of remaining forest cover per year (Sanchez-Azofeifa et al., 2001). To address this and other environmental issues, Costa Rica began building a system of national parks and private reserves in the 1970s, which today encompasses over one quarter of the national territory. Yet deforestation in non-protected areas continues to occur, threatening to isolate protected areas as forest islands (Sanchez-Azofeifa et al., 2003). Further expansion of non-extractive protected areas is impractical, if not inappropriate, given Costa Rica's population growth rate of 1.7% (World Bank, 2007) and lingering concerns over lack of just compensation for private property incorporated into the current park system (Steed, 2003). PES emerged in Costa Rica partly in response to the need for addressing land use choices on private property.

In much of Latin America, the forestry sector has a long history of government subsidies through interest-free loans, tax exemptions, provision of seedlings, extension services and even direct payments (CIFOR, 1999). In recent decades Costa Rica has been no exception (Brockett and Gottfried, 2002). Evolution of forestry incentives began in the late 1970s with tax credits aimed at offsetting the costs involved in establishing and managing forest plantations. See figure 3-1 for details.

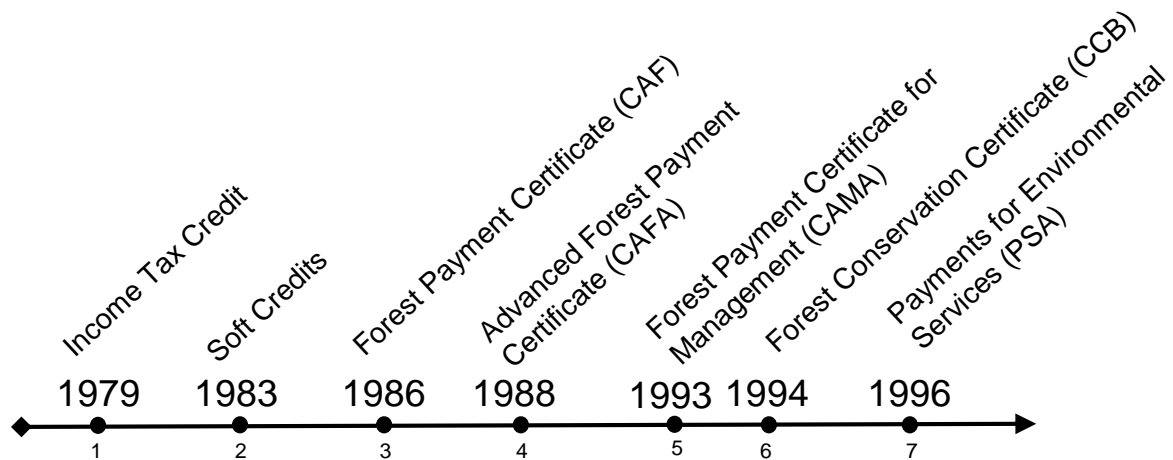


Figure 3-1. Timeline Detailing the Evolution of PES in Costa Rica

¹Decree No. 10521-AH, Sept. 1979. Income tax credit given to land owners involved in reforestation activities to offset the cost of plantations. The concept was to promote plantations as a way of alleviating deforestation pressure on natural forests. This tax credit targeted large landholders since small holders generally did not pay income tax.

²COREMA-AID project. International funding helped to finance low-interest reforestation loans with long grace periods and extended repayment windows. This initiative was the first of several soft credit incentives, some of which still continue in the present (e.g. FONAFIFO-brokered loans for reforestation).

³Article 82 of the Second Forestry Law (No. 7032, La Gaceta 13; Circulo 84 – May 6, 1986) creates the Certificado de Abono Forestal (CAF). Reforestation investments in plantations are made up front by land owner and compensation is given later through a tradable tax voucher.

⁴Decree No. 18691-MIRENEM-H, Dec. 1988. Like CAF but compensation is given prior to reforestation investment so that land owners with less capital could participate.

⁵Decree No. 22452-MIRENEM-H, 1993 (La Gaceta 170, Alcance 6). Established that scientifically-managed timber extraction from natural forests would be eligible for tax vouchers.

⁶Decree No. 23101-MIRENEM-H, April 1994 (La Gaceta 74). Established that tax vouchers could be paid for natural forest protection (equal to the CAF vouchers paid for reforestation).

⁷ Fourth Forestry Law (No. 7575, Gaceta 72, Alcance 21 – April 16, 1996). Article 22 affirms continuation of tax vouchers for protecting natural forest, along with other tax benefits. Article 24 provides that land owners voluntarily allowing forest regeneration are eligible for the same benefits. Article 29 details tax benefits for plantation owners.

From remarkably favorable credit conditions, to tradable tax vouchers, Costa Rica used subsidies to promote growth in the forestry sector. Over time, however, international pressure mounted to eliminate such subsidies. An acute financial crisis in the early 1980s saw the country become the first in a series of Latin American nations to default on international loans (Lara, 1995) at a time when their per capita debt load was among the highest in the developing world (Biesanz et al., 1982). Subsidies to the forestry sector were politically unsustainable since Costa Ricans failed to see much contribution from forestry to the local economy. The third World Bank loan negotiated during the ensuing structural adjustments abolished subsidies to the forestry sector (Watson et al., 1998). Yet Costa Rica cleverly turned the subsidy concept on its head by articulating the broader social cost of deforestation and the need to compensate private landowners for the ecosystem services their forest stewardship provides. Thus, Costa Rica's archetype PES program evolved seamlessly from the existing trajectory of forestry incentives (Figure 1), shifting the nominal focus from timber to conservation. Capacity-building and ecological awareness played an important role in affording this policy evolution.

The authorizing legislation for PES in Costa Rica was the fourth national forestry law passed in 1996 (Ley 7575, 4-16-96, Gaceta 72, Alcance 21). Ley 7575 recognizes four environmental services provided by forest ecosystems: biodiversity, watershed function, scenic beauty, and greenhouse gas mitigation through the storage and sequestration of atmospheric carbon. Landowners may sell their environmental services through one of several modalities³ that currently include (a) reforestation through plantations, (b) protection of existing forest, (c) natural forest regeneration, and (d) agroforestry systems (Gaceta 51, 3-13-07). Table 1 reviews the criteria and implementation history for Costa Rica's PES approaches. The payment per hectare is the same for all landowners within each modality.

Payments occur for five years, during which the PES-related land-use restriction is supposed to be noted on the property title to ensure that the service provision continues even if a property is deeded to another party.

Each year a program budget and PES procedures manual are published by the Ministry of Environment and Energy (MINAE) and the PES administrative agency, the National Forestry Financing Fund (FONAFIFO), respectively. MINAE determines the distribution of funds across modalities and also provides some direction with regard to priority zones for each method.

³ In this context modality refers to category.

Modality	Status	Criteria	Payment	Priority	Citation
Forest Protection	Dates from adoption of Forest Law 7575 (1996) to present (1)	(2) 3.4. Between 2 and 300 hectares enrolled (2) 3.6. Maximum 600 hectares (within indigenous areas)	(3) 2(a) \$64 per hectare per year (provided over five year period and renewable)	(2) 2.2.1. SINAC biological corridors; 2.2.2. Existing biological corridors; 2.2.3. Protection of AyA hydrologic resources; 2.2.4. Unpurchased protected areas; 2.2.5. Locations in cantons with MIDEPLAN Social Development indexes lower than 40%	(1) Ley Forestal N° 7575, publicado en La Gaceta 72 del 16 de Abril del 1996. (2) Reglamento N° 9, Manual de Procedimientos para el pago de Servicios Ambientales, FONOFIFO, publicado en La Gaceta 51 del 13 Marzo del 2007.
Reforestation	Dates from adoption of Forest Law 7575 (1996) to present (1)	(2) 3.1. Between 1 and 300 hectares enrolled; 3.2. Maximum 50 hectares enrolled; 3.3. Minimum 50 hectares enrolled.	(3) 2(b) \$816 per hectare over ten-year period	(2) 2.1.1. "High potential" forest plantations; 2.1.2. Areas with threatened species; 2.1.3. Pastures defined as Kyoto lands; 2.1.4. Projects under natural regeneration for at least one year	(3) Decreto Ejecutivo N° 33226, MINAE, publicado en La Gaceta 141 del 21 de Julio del 2006. (4) Reglamento N° 0, FONOFIFO, publicado en La Gaceta 151 del 8 Agosto del 2006.
Natural Forest Regeneration	Dates from first mention in 2005 to present (5,6)	Minimum 2 hectares enrolled (2) 3.5.	(3) 2(c) \$41 per hectare per year (provided over five year period and renewable)	None specified	(5) FONOFIFO, http://www.fonafifo.com/text_files/servicios_ambientales/montos.pdf , (2007)
Agro-forestry Systems	Dates from 2003 to present (5)	(2) 3.7. Minimum 350 trees, maximum trees per participant; 3.8. Maximum 336,000 trees per joint project, cooperative or indigenous reserve; 3.9. Specific requirements per hectare and square km.	(3) 2(d) \$1.30 per tree (provided over three year period)	(2) 2.3.1. Projects with organizations with FONOFIFO agreements; 2.3.2. Land as described in (1)Ministerio de Agricultura y Ganadería. 1995. Metodología para la Determinación de la Capacidad de Uso de las Tierras de Costa Rica. San José, Costa Rica. 60p. 2.3.3. Areas with specific agreements with FONOFIFO	(6) Reglamento N° 2, FONOFIFO, publicado en La Gaceta 26 del 7 Febrero del 2005. (7) Decreto Ejecutivo N° 30478 MINAE, publicado en La Gaceta 112 del 12 Junio del 2002.

Forest Management	Dates from adoption of Forest Law 7575 (1996) until 2002 (1, 7).	Criteria determined by conservation area (8) 5.1-5.10	(8) \$123,540 (or about \$343) per hectare (provided over five year period)	(8) 5.1-5.10 Priority determined by conservation area (SINAC)	(8) Decreto Ejecutivo N° 30090, MINAE, publicado en La Gaceta 32 del 14 de Febrero del 2002.
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Table 3-1. Legal Status of PES Modalities.

From the publication date of these executive decrees each year, interested land owners meeting the requirements have fifty days to submit the necessary paperwork to the appropriate regional FONAFIFO offices. Generally, the program can only accommodate about a quarter of the annual applicants into the scheme. By design, FONAFIFO should prioritize contracts within biodiversity conservation corridors identified by the GRUAS reports (García, 1996; Castillo, 2006) and through annual consultation with the national system of protected areas (SINAC) within MINAE (Rojas and Aylward, 2003). In practice, however, prioritization of PES contracts varies regionally. Regions that were not targeted by the World Bank-funded Mesoamerican Biological Corridor initiative, and/or that lack a strong civil society presence to conduct outreach, may operate on a first-come, first-served model of prioritization out of logistical necessity (Daniels, personal observation).

Each contracted environmental service provider must have a formal forest management plan designed by a professional forester, regente, according to the specifications of the modality in which they are participating (Article 20, Ley 7575). The fixed cost of this activity is taken off of the top of the program payment and is thus proportionately higher for small holders. Other responsibilities include posting signage on the land declaring that it is protected from hunting, fire and logging (Article 12, Gaceta 51, 3-13-07). The same regentes that write management are required to perform a site visit every twelve months for the life of the contract (Article 10.2, Gaceta 51, 3-13-07). plans are charged with monitoring compliance with PES regulations (Article 21, Ley 7575). Regentes 172

2.2 Empirical Trends for Costa Rican PES

The mean annual PES budget over the last decade exceeds \$13.3 million USD or 0.43 percent of Costa Rica's 2006 national budget.⁴ To put this in perspective, the entire EPA budget for 2006 comprised 0.0003 percent of the U.S. federal budget or three orders of magnitude difference relative to this single program within Costa Rica's portfolio of conservation initiatives. The extent of Costa Rica's investment in PES underscores their commitment to conserving environmental services by addressing land use management on private property. It also highlights the importance of iteratively reviewing the institutional design of PES and its implementation in the name of enhancing efficiency and efficacy.

Overall budgetary efficiency, plotted as cumulative area enrolled in PES versus cumulative PES budget, corresponds roughly to the five year payment cycles (Figure 2A). The slope between data points for individual years represents the gain in PES area per unit of FONAFIFO's annual budget. Recruitment of area into the PES scheme diminished per unit of the budget over the first years of the program, up through 2002. This is a function of having to spend an increasing portion of each successive annual budget servicing contracts from past years. By 2002, the 1997 cohort—the largest in the program's history with 102,784 ha—had finished receiving payments and program efficiency increased markedly. Conceptualizing PES as a cumulative forest protection scheme for the provision of environmental services as in Figure 3-2a assumes that land

⁴ Data Sources: PES budget: FONAFIFO, Costa Rica 2006 National Budget: CIA World Fact Book, EPA 2006 Budget: EPA website, US 2006 National Budget: CIA World Fact Book expired

owners will abide by Article 19 of Ley 7575 once the payment period has expired. That is, land owners will continue to protect and maintain forest cover as mandated under the law so that PES investments have cumulative and lasting effects for environmental service provision. In practice, however, Article 19 is somewhat unrealistic and is weakly enforced.⁵ For example, within the forestry modalities of PES, land owners may choose not to re-plant a plantation site after timber harvest and the expiration of the PES contract. In the forest protection modality of PES, the common practice of forest thinning and/or clearing of the understory (socolando) may ensue after the payments end, making the gradual land use change difficult to detect (Daniels, personal observations).

Figure 3-2b illustrates the difference between the best and worst case PES implementation scenarios respectively. The upper curve represents conservation of all PES forest, even after payments end—likely an unrealistic scenario. The lower curve represents conservation of only the forest areas receiving contract payments (i.e. forest area for expired PES contracts is subtracted off the running cumulative area). Institutional design and supporting forest conservation policies are critical in determining where the empirical curve falls between these two extremes.

⁵ Article 19 of Ley 7575 was instrumental in establishing a favorable context for PES, but is problematic in its implementation. With regard to opportunity cost, the program payment (no matter how low) technically always exceeds the land rent from the next best land use, given that it is illegal to change from forest land use to another activity.

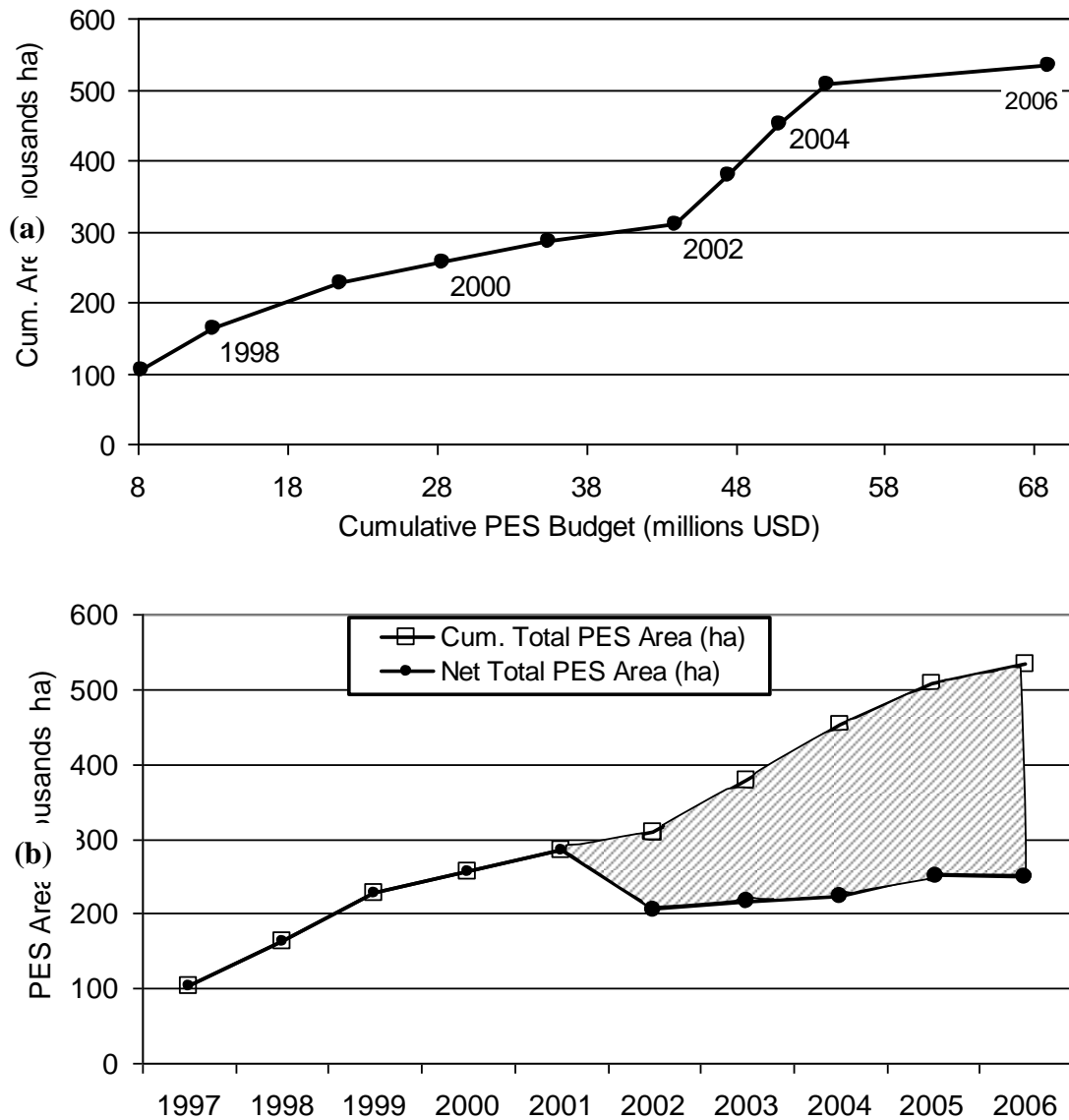


Figure 3-2. (a) Cumulative area in PES (thousands of ha) as a function of the cumulative budget (millions USD) FONAIFFO receives to implement PES (b) Time series of cumulative PES area (thousands of ha) recruited across all modalities (square) in contrast with net area where expired contracts are subtracted off of the running sum (circle). The shaded region between the two curves represents the difference between the best and worst case PES implementation scenarios respectively where one-hundred percent of PES forest is conserved even after payment period ends (defining upper limit of region) or where none of the contracted forest is conserved after payments end (defining the lower limit of region). PES scheme design is critical in determining where the empirical curve falls between these two extremes.

Another aspect of budgetary efficiency relates to hectares per contract for individual land owners. Figure 3-3 illustrates that across some time steps (e.g., 1998 to 1999), the total PES area recruited may increase while the number of contracts stays roughly the same. This means the area per contract is greater and the relative administrative cost per hectare recruited is lower. In contrast, from 2004 to 2005, the number of contracts is constant while the recruited area drops precipitously (i.e. area per contract is much smaller). This indicates a tradeoff between program efficiency and equitable distribution of environmental service contracts across the range of property holdings.

The overwhelming majority (89%) of recruited PES area throughout the history of the program has been for the forest protection modality, with only five and six percent falling in the reforestation and management modalities, respectively. The budgetary breakdown, however, is somewhat different given that payments per hectare of the timber-related modalities is over twice the payment level for forest protection in order to cover the higher costs of planting and technical assistance (Table 1). A decrease in recruited PES area from 2004 to the present reflects the implementation of the agroforestry modality which is based on payments per tree rather than area of forest contracted for environmental service provision (Figure 3-3).

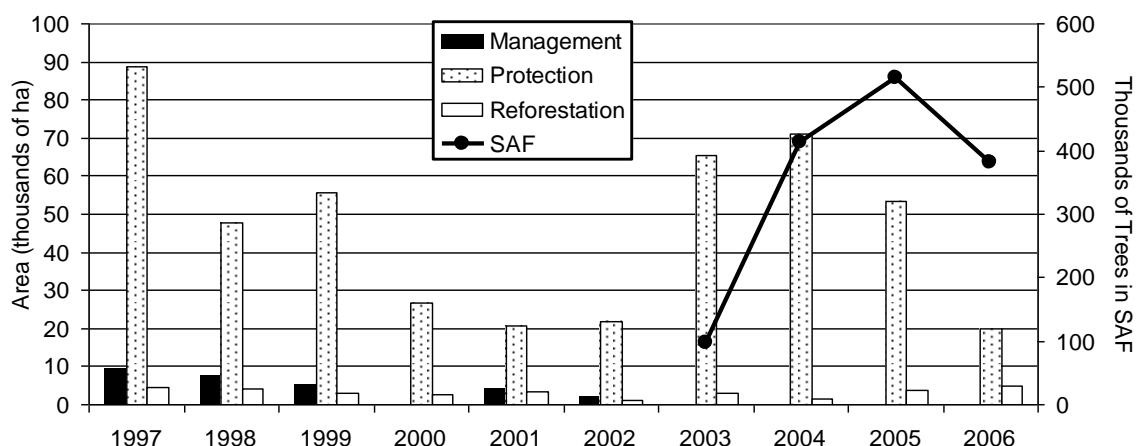


Figure 3-3. Time Series of the Recruited Area per Modality and Number of Trees in the Agroforestry Modality (SAF).

Over the last decade, Costa Rica's PES program has purchased ecosystem services from over half a million hectares of land in "forest use" (5,314 km²), including regenerating forest and plantations at various stages of the timber production cycle (Figure 3). As such PES has provided a significant private-property complement to the country's network of national parks, which comprises only slightly more area (5,415 km²). As Costa Rica begins implementing a new phase of PES (corresponding to a second World Bank/GEF-sponsored project), reflecting on institutional design at this point should enhance existing arrangements and facilitate innovations that further improve PES performance.

3. Evaluating Costa Rica's PES program

3.1 PES Administration

FONAFIFO, the semi-autonomous arm of MINAE that administers PES, has considerable freedom and flexibility with regard to how the program is implemented. A

1990 budgetary law (Article 32, Ley 7216, Gaceta 245, Alcance 48, 12-26-90) created the agency and charged it with financing forestry initiatives among small and medium-sized producers. As such, the institutional strengths of FONAFIFO arguably lie in its forestry-related capacities. The agency was charged with managing the PES scheme only since 1996 (Article 46, Ley 7575).

FONAFIFO's Board of Directors (Article 48) is comprised of two representatives from the private forestry sector, one industrial and one small to medium-sized producer group (e.g., JUNAFORCA); one representative from the Ministry of Agriculture; one from the national banking system; and a single representative from the Ministry of Environment. The Board essentially writes the executive decrees defining explicit participation criteria, modalities and payment details in the annual PES Procedures Manual. This leadership structure and the historical role of FONAFIFO prior to PES may have set forth some degree of institutional path-dependency, restricting PES design and implementation innovations to a degree. Political pressure from the forestry lobby has further reinforced this structure.

FONAFIFO's particular institutional structure has both positive and negative consequences regarding PES objectives. Benefits of the forestry-bias to date include the development of progressive, technically-sound small forestry operations that have at least nominally contributed to rural development. By facilitating the establishment of such forestry plantations, the scheme design may reduce legal and illegal logging pressure on

natural forests.⁶ Plantations also generate carbon credits with potential for sales on the international market, thereby creating a positive feedback for PES funding (e.g., a current proposal for the World Bank's BioCarbon Fund). The negative consequence of the institutional forestry bias from a conservation perspective is that ecosystem services provided by plantation land use are production-biased relative to those provided by natural forest cover. To date, the scheme has identified generalized categories of environmental services provided by land uses (i.e. modalities) already employed in pre-PES forestry incentives (Figure 1), as opposed to identifying ecosystem functions and services, and defining with greater nuance what land cover, land use and management practices best provide these services. New modalities are currently being proposed, however, and will be regionalized according to local needs (World Bank 2006).

A holistic approach to forest ecosystem service provision and management requires that production, consumption and conservation issues be addressed in lockstep to enhance net levels of service provision. The tradeoff between production and conservation modalities, however, has been highly politicized since the beginning of PES in Costa Rica. Sound planning and rational discourse sometimes get lost in the propaganda from the two artificially-distant extremes. For example, the forest management modality was eliminated entirely in 2002, arguably on principle alone, reflecting the delicate balancing-act that FONAFIFO and policymakers face in sustaining support for PES in Costa Rican society. Unfortunately minimal rigorous peer-reviewed research exists to objectively provide insights regarding the optimum distribution of PES

⁶ A decade ago, fifty percent of local timber came from natural forests compared with only five percent today (MINAE/National Forest Office, 2004).

area and funding across modalities for a range of different economic and ecological scenarios.

From 1990 through 2003, FONAFIFO's role was largely that of a bank. In essence, its mandate is still financial in nature—collecting, managing and dispersing funds through payments and loans (Article 46, Ley 7575). Yet, PES implementation entails a host of administrative, information-systems, and monitoring/reporting considerations which the agency accomplishes using less than ten percent of its given annual budget. In 2003, FONAFIFO took PES field administration from SINAC through the staffing of eight regional offices (housed within regional SINAC offices). Over time, the agency has become savvier in managing the challenging ground-based logistics of PES implementation. Decentralization has enhanced both efficiency and accessibility for interested landholders. The eight administrative zones are divided into geographic regions that do not correspond to natural landscape units like watersheds, however.

Monitoring for Costa Rica's PES scheme is weak and leaves room for improvement. The duty of all field verification, management plan drafting and monitoring falls, by design, to third party agronomists and foresters (regentes) compensated by PES participants out of the program payment (Article 21 of Ley 7575). Contracted foresters may have a disincentive to report non-compliance with PES contracts since they may fail to receive compensation if a non-compliant PES contract is disqualified. Further, regentes may lose the non-compliant contract from their portfolio of managed contracts. Since regentes have public faith (fe publica), there is little oversight of their work. FONAFIFO's Board of Directors has been slow to develop explicit criteria

and procedures that regentes should follow during the initial and follow-up site visits. For example, only in 2004 did the Procedures Manual specify how, where and in what units GPS points should be taken on-site by the regente to identify the property being contracted for PES (Gaceta 46, 3-5-04). Data collected prior to 2004 were often recorded in a variety of incompatible map datums and projections. Only in 2006 did the manual require regentes to begin mapping the actual contracted forest area within the larger landholding. This marks a dramatic improvement as officials, researchers and conservation groups may now use remote sensing methods to complement field-based monitoring and begin to systematically quantify the impacts of PES on forest cover.

FONAFIFO has demonstrated its capacity to effectively incorporate lessons-learned by adapting its administrative design. Nevertheless, the PES monitoring mechanism still merits considerable re-thinking. First, foresters may not always be the most appropriately trained for evaluating ecosystem services or monitoring their provision, particularly as new modalities are added in the future. A more robust approach incorporating ecologists, hydrologists, geographers, ecological economists and landscape planners may be beneficial. Greater monitoring oversight, including penalties for hasty technical work, is also needed. The program should move toward completely decoupling the financing of monitoring from the act of monitoring itself. For example, fees now paid directly to regentes could be deposited into a general fund for each region. Then payments could be made out of the fund to regentes randomly assigned to perform follow-up visits, without regard to which regente had written the original management

plan. In this way, regentes could better self-police in executing technical and monitoring duties.

3.2 Opportunity Costs

The payment amount for Costa Rica's PES program has long been a topic of debate. In theory, the payment should exceed the land rent earned for the next-best land use option (i.e., the opportunity cost). Payments were derived from calculating an average opportunity cost for the most immediate land use option prior to PES initiation over a decade ago, which was assumed to be cattle ranching. Since that time, FONAFIFO has annually adjusted payments upwards, to minimally match inflation (with a marked increase in 2005). There are several problems with this approach. Land rent for cattle ranching varies greatly depending on location and specialty (breeding, dairy or meat). Cattle ranching was relatively less profitable due to low beef prices at the time (Arroyo-Mora et al., 2005). And finally, low-intensity cattle ranching is no longer necessarily the most immediate land use alternative as some regions of Costa Rica have been moving away from this extensive production model toward higher-intensity land uses (Daniels, in prep).

Intensive agriculture and development/urbanization are increasingly prevalent land use options. Sites suitable for cultivating export-grade pineapple, for example, can be rented for about \$390/ha per year or sold for around \$5800/ha (Oviedo, 2006). Such high land rent is possible by externalizing the costs of environmental degradation like water pollution. As long as local to international laws and institutions fail to internalize

social costs, PES may be less competitive, highlighting the importance of policy coherence in effective PES implementation (Costanza and Farley, in prep.). The PES payment of \$41/ha per year for natural forest regeneration or \$64/ha for forest protection is trivial for those interested in profits alone, if their land is suited for intensive agriculture. PES is thus generally more attractive on marginal lands, which may or may not provide ample levels of ecosystem services for a particular landscape or region (see section 3.6). Rapid development in some regions increases the need for environmental services that reduce peak stream flows and prevent flooding (Marsik and Waylen, 2006). Nearly three million square meters of new construction were permitted within Costa Rica in 2004 alone (Estado de la Nacion, 2006). Yet the very process of urbanization often precludes even the consideration of PES because of the comparatively immense one-time profit that a landowner can earn by selling their property. Land speculation and real estate development are particularly prevalent in coastal regions and in the urban Central Valley. Zbinden and Lee (2005) point out the need for more research on opportunity cost dynamics in Costa Rica. The long-term viability of PES depends upon addressing these difficult issues of modern-day land use competition openly without being perceived as a threat to PES validity and utility.

Consideration of how Costa Rican land use economics have changed in recent years underscores the importance of a PES design that incorporates a feedback loop for changing economic contexts. Periodic updates regarding opportunity costs could be used in conjunction with PES contract “laddering” to ensure provision of ecosystem services over appropriate time scales despite economic change. That is, rather than having a fixed

term (currently five years) for PES contracts, laddering over different term lengths with higher payment rates for longer contracts would help ensure at least some critical level of environmental service provision even when market conditions make PES a less-attractive land use. Furthermore, a vast literature on adoption of conservation-friendly management practices and land use decision-making suggests that the process is far more complex than accounting for farm profit levels alone (Godoy, 1992; Ayuk, 1997; Neupane et al., 2002; Berentsen et al., 2007). This suggests that there may be room for outreach and education to enhance consideration of the non-monetary factors involved in the decision to participate in PES (e.g., the long-held Costa Rican ideal of maintaining the small family farm appears to play an important role). Ecosystem services valuation must be tied to overall quality-of-life considerations. Improved understanding of the dynamics between natural, social, built and human capital can help better inform appropriate land use decisions (Costanza et al., 1997; Costanza, 2001).

3.3 Ecosystem Service Bundling

The natural functioning of ecosystems delivers inseparable “bundles” of ecosystem services (Brennan, 1995). Often, service delivery occurs in synergistic fashion, especially between adjacent ecosystems. Certain management strategies, however, can enhance some services relative to others, or even result in their total loss. Prudent ecosystem service management requires considering complementarity (e.g., riparian forest habitat and enhanced water quality) or competition (e.g., forest habitat versus food production from a cleared agricultural field) among services. Figure 3-4 conceptually

illustrates a multi-dimensional production possibility frontier for several ecosystem services. One reasonable management objective could be to increase the volume defined by the provision level of interacting services. Given a target level for a focal service, another goal could be to achieve the corresponding maximum provision level for other bundled services as illustrated. Unfortunately, however, many ecosystem service tradeoffs are still either unknown or poorly understood (Rodriguez et al., 2006).

Costa Rica's PES program bundles the sale of ecosystem services. The assumption is that the prescribed land use of a given modality will result in the provision of at least one or more of the four environmental services specified by the program. Yet the different modalities leave room for various levels of service provision, with a somewhat nebulous link between the modality, level of service provision and flat payment rate. Differentiated payments would better reflect the degree of ecosystem service bundling provided by a given contract and have been proposed for future implementation in Costa Rica (World Bank 2006). For example, land that contains old growth forest cover would certainly store more carbon, while simultaneously providing greater biodiversity, than equal area of early successional forest within the same life zone. The PES program might consider paying more for the old growth forest within its forest protection modality. Differentiated payments could provide part of the missing link in the current institutional design toward maximizing the service provision volume depicted in Figure 3-4. Furthermore, allowing graduated payments through multiple tiers of ecosystem services within a modality may increase PES retention and reenlistment.

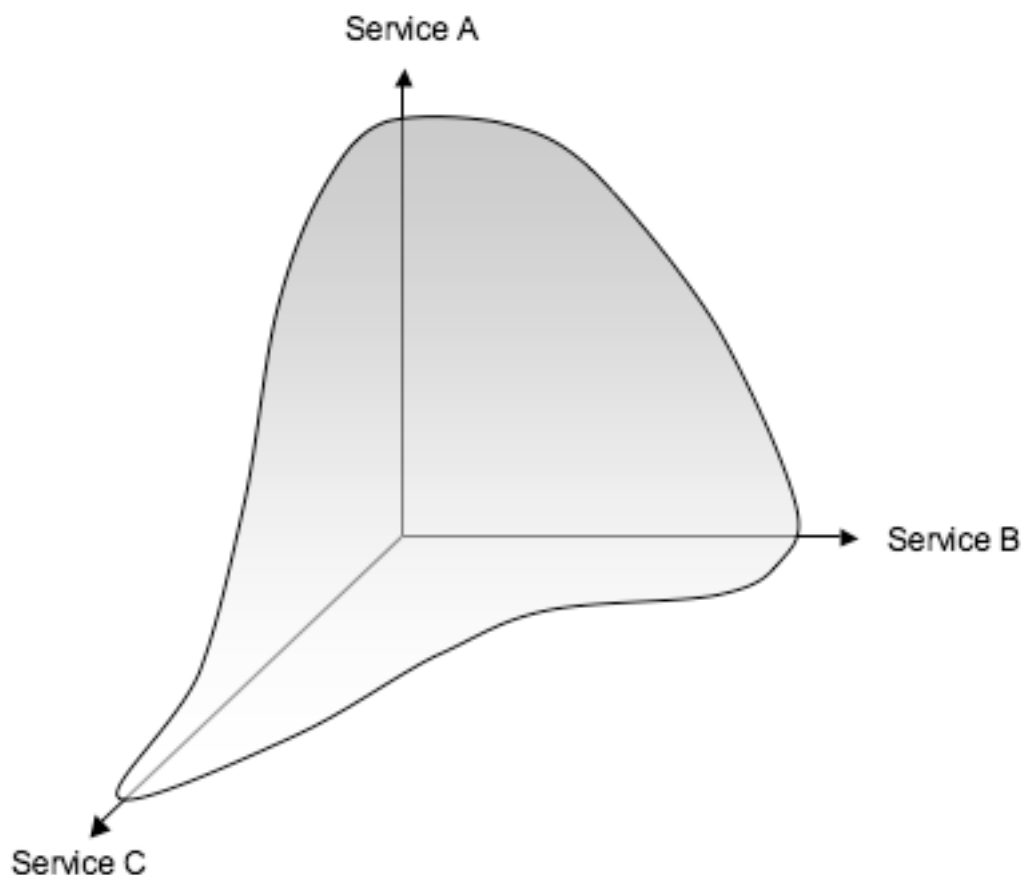


Figure 3-4. A Conceptual Multi-dimensional Production Possibility Frontier for Ecosystem Services. Bundling ecosystem services entails maximizing the volume defined by provision levels of interacting services

3.4 Sustainable Financing

A successful PES program must have the appropriate mechanisms and political will to capture funding from a wide range of ecosystem service beneficiaries. Costa Rica’s scheme successfully exemplifies this – a monopsony that captures ecosystem service “sales” across multiple scales. The scheme indirectly connects local, regional and international buyers of ecosystem services to individual land owners (Figure 3-5).

Locally, for example, a new decree is being phased in over the next seven years (Decreto 32868, Gaceta 21, 1-30-06) where water concessionaires pay a fixed tariff that gets invested in watershed protection. Internationally, Costa Rica has marketed discrete carbon storage/sequestration services such as the \$2 million certified offset sold to Norway in 1997. FONAFIFO successfully bundles ecosystem services, while simultaneously exploiting markets for the sale of discrete services.

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are needed to see this picture.

Figure 3-5. Costa Rica's Model for Using Institutions to Bundle Services Linking Buyers and Sellers Across Different Spatial Scales.

Sustainable financing mechanisms improve the likelihood that resources will be available to continue funding PES programs into the indefinite future. Figure 3-6 illustrates the continuum of relative financial sustainability among funding sources both within-country and internationally. Reliance on external loans and grants is the least secure PES financing source. Costa Rica has benefited from being a pioneer in the field of PES. Yet as other nations begin or expand PES initiatives, Costa Rica may face greater competition for such funding, stressing the need to begin pilot-testing designs that enhance efficiency.

Funding from	Internal	Internal	External	Internal	Internal	External	External
Revenue source	Tax/fee on good or service with inelastic demand	Tax/fee on good or service with elastic demand	Compulsory payments under international treaty	Voluntary payments	Funding from general budget	Grants or voluntary payments	Loans
Example	Tax or fees on energy or water users	Tax or fees on luxury goods or tourism	Carbon credit or biodiversity purchases under strong international treaties	Payments from firms (e.g., Cerveceria Costa Rica)	General appropriation subject to renewal	GEF grants; Norway's pre-Kyoto carbon credit purchase; U.S. voluntary	World Bank loans

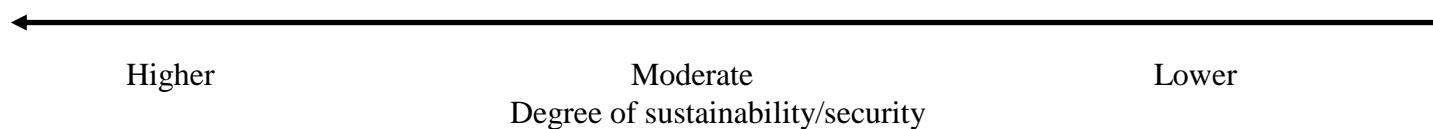


Figure 3-6. Relative sustainability/security of financing mechanisms for PES

						carbon markets	
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Stronger international treaties on biodiversity and climate change that require payments for international public goods would provide a more secure external funding source (Farley et al., in prep.). Such arrangements would reduce free riding by developed nations and contribute to PES success by enhancing the demand-side of environmental markets.

Within-country, financing may entail voluntary payments, funding from the general budget, or funding from a specific activity. Voluntary purchases, like FONAFIFO's innovative Environmental Service Certificates (CSAs) sold to local utilities like Energía Global, provide funding but allow free riding by non-purchasing firms. CSAs are certificates of bundled ecosystem services that any entity may purchase. In practice, CSAs function like a donation to the PES scheme, but the concept is radically different. Great potential exists for enhancing CSA sales through an eco-friendly certification process for tourism-related businesses. Criteria for the certification might include carbon-neutrality, biodiversity conservation, and enhancing hydrologic functions (e.g., offsetting diminished aquifer recharge for each square meter of constructed surface area). Firms could provide these environmental services on their property or through purchasing CSAs. This would generate revenues for PES while internalizing some of the environmental and social costs of the largest foreign currency-earner in the Costa Rican economy, tourism (Brockett and Gottfried, 2002). Currently, however, few tourism businesses in highly-visited areas appear to be aware of CSAs, underscoring the need for an outreach mechanism to capture such sales.

PES funding from a nation's general treasury risks competition from numerous other budgetary needs. Therefore taxes or fees on goods or services related to

provisioning of ecosystem services are more sustainable revenue sources for PES. Costa Rica has a fuel tax, currently about 28 cents/liter of gasoline (Decree 33570, 1-8-07). By law 3.5% of the revenues should be channeled to FONAFIFO to fund PES (Article 5, Ley 8114, 7-9-01), significantly less than the originally-intended one-third of revenues. This design is conceptually sound since it requires polluters to pay for the atmospheric waste absorption capacity for CO₂. However, revenues first pass through the Ministry of Finance where competition for other legitimate uses, e.g., the Costa Rican social security system, is understandably great. Fuel tax revenues actually dedicated to FONAFIFO do not always meet their intended level. Three and one-half percent of fuel tax revenues would be about \$8.6 million per year (Miranda et al., 2006), but FONAFIFO's budget has been as low as \$3.1 million in 2005. Government estimates of income tax evasion in Costa Rica are high (Lutz and Daly, 1991; O'Grady, 2006), though recent reforms have shown promise in turning this trend around (Umaña, personal observation). The fuel tax gap may arguably be making up for much-needed revenues. The PES funding shortfall creates a gap between the supply of landowners interested in PES and the demand FONAFIFO can generate with its given budget. Both the water tariff and fuel taxes apply to goods with inelastic demand. Such taxes should be more sustainable under changing economic conditions than those on goods or services with more elastic demand, like tourism.

Biodiversity services have proven especially challenging for developing targeted financing instruments at the local level. Costa Rica has devised a particularly innovative and sound strategy to capitalize a trust fund (The Trust Fund for Sustainable Biodiversity

Conservation) that will serve as the financier of last resorts. The fund will target zones of globally-significant biodiversity that do not overlap with existing carbon and water-related PES funding mechanisms (World Bank 2006).

3.5 Equity in Funding PES

Sustaining funding for PES involves iterations of internalizing ecosystem services at the local, regional and global levels. An important component of sustainable funding mechanisms is rooted in effectively dealing with free riding - the act of benefiting from a service without paying for it (Olson, 1965). Globally, Costa Rica provides biodiversity conservation and carbon sequestration, services that yield global benefits yet most recipients at the global scale do not pay for these benefits (Farley et al, this issue). Both of these services are considered to be non-rival and non-excludable, placing them in the public goods realm (Samuelson, 1954; Randall, 1993). Who is responsible for managing and financing these services? Theory advises that governments should have a significant role in managing and directing general funds for non-excludable services (Randall, 1993; Daly and Farley, 2004). However, drawing from a country's internal general funds does not reflect the larger benefits to global society.

On a regional scale, scenic beauty is considered a non-rival but excludable and congestible service, because overuse of the landscape could diminish or potentially eradicate aesthetic qualities (Randall, 1993). One logical way to preserve the quality of a congestible service is to consider it a public good, which can then be subject to user fees

or other methods of management (Randall, 1993; Bengston and Youn, 2006). Obvious users include tourists; past negotiations have occurred between actors such as hotels, rafting companies and tour industries (Pagiola, 2006). Yet because there is such a vast range of users in Costa Rica, identifying and maintaining a collective base from which to acquire funding is difficult. One way might be to implement a tourist fee, which would more evenly distribute the cost among the beneficiaries. Currently, visitors and citizen air travelers alike pay an exit fee of US \$26; an additional fee may be a simple way of using an established channel for funding scenic beauty provision. This would widely spread the burden of payments while increasing the funding pool. Reasonable thresholds could be established through willingness-to-pay surveys and by examining similar payment schemes. This mechanism does not burden the poor, since no such exit fee exists for land-based border crossings.

On a local level, the free-riding issue for water conservation stands to be controlled by the new water tariff, once implemented nationwide. The tariff will effectively equalize costs across all concession holders. Yet, if the tariff is passed on to users, it may disproportionately burden the poor since, albeit a negligible \$0.003/m³ (Article 5, Decreto 32868), it constitutes a higher percentage of their total income. The fuel tax charges citizens for carbon sequestration by forests, standardizing the funding of this service across local beneficiaries; but international beneficiaries continue to free-ride (Farley et al, this issue). Free-riding also occurs for biodiversity protection, as similar such measures do not exist to explicitly charge local beneficiaries.

3.6 Spatial Variability and PES Targeting

Ecosystem processes, climate, disturbance, and characteristics of human user populations clearly vary across Costa Rica's diverse geography, and interact to influence ecosystem service provision. Yet the flat payments in Costa Rica's PES scheme to-date fail to account for this variability. Carbon storage and sequestration vary greatly by forest type and successional stage (Rojas and Aylward, 2003). Landscape beauty is likely greatest in places of high visibility – (e.g., along roads, mountaintops). Areas of high biodiversity value are identified through the GRUAS reports (García, 1996; Castillo, 2006). Hydrologic services present scientific uncertainty as well as spatial dependence on human user populations. Forest type, climate, and landscape setting are all key factors influencing hydrologic services (Chomitz et al., 1999). De Camino et al. (2002) developed a qualitative ranking system for ecosystem service provisioning by forest type, which could provide a basis for more empirical measurement of service provision differences, as proposed in the next phase of Costa Rican PES. Benefits from diverse services can be aggregated using indices (e.g., the U.S. Conservation Reserve Program “environmental benefits index” or Australia's BushTender “biodiversity quality index” (Chomitz et al., 2006).

Popular wisdom suggests that forests regulate high and low flow events, increase total water supply, and reduce erosion and sedimentation. Scientific evidence, though, presents a more complex and site-dependent view (Bruijnzeel, 2004; Bruijnzeel, 2006; Kosoy et al., 2007). Key findings of studies relevant to Costa Rica's PES program include: 1) Runoff is less in forests, except for cloud forests. 2) Dry season flow and

groundwater recharge contributions from forests are site-specific, and largely depend on local geology, tree species composition, and successional stage. 3) Peak flows are mitigated in newly regrowing forests, but full benefits are achieved once complete vegetative cover becomes established. This effect is most prominent in small watersheds, and less important with increasing watershed area. 4) Forests encourage more rainfall only in cloud forests or over large geographic areas (e.g., the Amazon). 5) There is greater scientific consensus about the water quality and sediment reduction benefits provided by forests. Despite uncertainty about hydrologic services, utilities in Costa Rica have renewed their CSA contracts for the purchase of environmental services, indicating their satisfaction.

On an annual basis and at the nationwide scale, Costa Rica receives far more rainfall ($170 \text{ km}^3/\text{yr}$) than its water use ($6 \text{ km}^3/\text{yr}$, Pagiola, 2006). Despite this abundance of moisture, spatial and seasonal variability can cause serious water shortages with nationwide consequences. Since about eighty percent of Costa Rica's electricity is generated in hydroelectric plants, the variability of rainfall relative to plant locations is a critical concern. This is particularly true during ENSO events since water levels in the Arenal reservoir, located in the driest Costa Rican province of Guanacaste, can be significantly diminished during El Niño (Amador et al., 2000). In fact, President Arias declared a national energy crisis in March 2007 due to insufficient electric production as a function of record-low water levels in concert with other malfunctions. Economic losses in the industrial sector alone summed to \$20 million in a single week within a longer period of rolling blackouts (Avalos, 2007). This underscores the critical nature of

considering spatial and temporal variability of hydrological functions. Appropriate spatial targeting of watershed services could offer greater resilience in times of climate anomalies and technical failures that affect national electricity supply.

Just as ecosystem service provisioning varies across landscapes, opportunity costs of their protection vary as well. In a general sense, environmental markets can improve conservation efficiency over command and control regulation by identifying specific locations or firms offering the lowest costs and greatest benefits (Tietenberg, 1989; Salzman and Ruhl, 2002; Pagiola et al., 2005a). Careful arrangement of PES payments may similarly achieve the same environmental benefits at lower costs. In a system of uniform payments, however, landowners with low opportunity costs receive rent from PES programs, reducing money available to spend elsewhere, while those with higher opportunity costs are unwilling to participate even if they could provide socially valuable ecosystem services. Through spatial targeting, payments can be matched to levels of service provision, eliminating the blunt subsidy nature of uniform payments across diverse landscapes (Salzman, 2005).

Tools for spatial targeting of ecosystem services have been developed and used in numerous geographic contexts and policy settings (Babcock et al., 1996; Babcock et al., 1997; Ando et al., 1998; Polasky et al., 2001; Stoms et al., 2004; Chomitz et al., 2006; Naidoo and Ricketts, 2006; Beier and Patterson, in review). Costa Rica's PES scheme might gain from implementing a spatially-nuanced approach that employs these kinds of tools (Chomitz et al., 1999; Ferraro, 2001). Wünscher et al. (2007) highlight the efficiency gains in targeting payments to landowners based on both service provision and

opportunity cost. They demonstrate that conservation gains for the Nicoya Peninsula in northwest Costa Rica would be 58-88% greater using a targeted PES system that ranked each parcel's total ecosystem services score and opportunity cost of service provision. The surveys that Wünscher et al. used to estimate opportunity costs are expensive and time-intensive, however, meaning they could undermine the efficiency gains of a spatial targeting. This is particularly true since both ecosystem functioning and opportunity costs are dynamic, requiring periodic updates that exceed the capacity of FONAFIFO's field staff. Thus, while a good theoretical concept, Costa Rica needs a more straightforward method to estimate landowner costs.

One solution might be reverse auctioning where landowners self-identify through a confidential bid. Potential service providers discretely submit to the buyer—in this case FONAFIFO—the price they would accept to enroll in the PES program (Stoneham et al., 2003; Latacz-Lohmann and Schilizzi, 2005; Salzman, 2005; Sierra and Russman, 2006). Reverse auctioning provides several clear benefits: it can prevent collusion and bidding up of prices among landowners; it is well-suited to monopsonies; and it can reduce, though not eliminate rent seeking (Chomitz et al., 2006) by reducing information asymmetry between the ecosystem service provider and buyer. Reverse auctions have been used in Australia's BushTender program (Stoneham et al., 2003; Salzman, 2005) and the U.S. Conservation Reserve Program. When the coordinating agency matches areas of greatest benefit and lowest cost, efficiency in ecosystem service provision is maximized. The buyer then accepts bids up to a budget threshold, service provision level, or cost-benefit ratio.

Latacz-Lohmann and Schilizzi (2005) show evidence from experiments, models, and real-world PES data demonstrating substantial gains in total ecosystem services provision on a fixed budget by targeting services and auctioning versus paying a fixed price. Efficiency gains may not be universal or measurably positive from auctioning, and can shrink over time as landowners learn how to strategically bid (Latacz-Lohmann and van der Hamsvoort, 1997; Latacz-Lohmann and Schilizzi, 2005). Careful auction design and selective information disclosure by the buyer are necessary to maintain efficiency when auctions are repeated over time. Adaptively testing spatial targeting and auctioning methods in different parts of Costa Rica could help determine their feasibility and utility while advancing the state of knowledge about efficient, fair, and sustainable PES systems. Currently, the GRUAS reports and other efforts provide for basic spatial targeting. Yet once superimposed, target areas cover seventy percent of the country, confounding spatial prioritization and meaningful clustering of PES properties (Sills et al., 2005). For many services, protecting adjacent land offers synergistic benefits. Designing proper incentives for multiple-landowner coordination is an important challenge for the Costa Rican PES systems (Latacz-Lohmann and Schilizzi, 2005) and may include allowing groups of adjacent landowners to bid together on conservation contracts in an auction format.

3.7 Socioeconomic Objectives

The potential exists for synergy between rural development and conservation goals, yet the relationship between PES and socioeconomic objectives is still largely

uncertain. Costa Rica's PES program aims "to benefit and augment the quality of life for rural populations whose lands possess forest or the potential for forest cover through silviculture" (Article 1 of Ley 7575). Though the law itself targets rural populations, evolution of the political discourse has re-framed the issue to center on whether PES positively benefits "the rural poor." At the national level, the majority of PES participants are small and medium landholders (Sills et al., 2005). Nonetheless, regional studies found that PES participants tend to have higher off-farm incomes, larger properties and higher levels of education than otherwise equivalent non-participants (Zbinden and Lee, 2005). Furthermore, a recent qualitative study in the central cordillera region found that the income generated from PES is used by the majority of poor participants for routine household expenses, precluding its application to longer-term savings or sustained quality-of-life investments (Esposito, in prep).

Thus, PES is probably contributing very little to enhancing the economic well-being of the poorest of Costa Ricans, since participants are on-average not among the poorest landholders; and even poor landholders are likely better off than the landless poor. Yet economic well-being is not equal to quality-of-life. Whether earning income from PES or not, the poorest and richest landholders alike benefit from greater landscape levels of environmental services afforded by the program. To-date, no indicators have been designed or measured for the latter in Costa Rica with regard to enhanced provision of ecosystem services through PES. Initiatives are underway to implement a PES-impact-monitoring system to better understand the degree to which socioeconomic objectives are being met (World Bank 2006). Perhaps a germane question at this juncture is, in precisely

what ways does Costa Rica hope PES benefits the rural population and what are the relative priorities (income, capacity-building or ensuring a healthy, safe environment)?

Several modifications over the last decade have attempted to facilitate smallholder participation. In key impoverished regions, FONAFIFO makes exceptions to the need for legal title when submitting PES applications provided that landholders meet certain requirements (see Decree 31633, La Gaceta 29, 2-11-04). Transaction fees have been reduced, though not eliminated, by allowing smallholders to form associations and enter PES “in bulk.” FONAFIFO has streamlined their information system with other government databases to facilitate verification of requirements (Pagiola, 2006). However, the degree to which these measures have facilitated access remains un-quantified. That there is no shortage of willing participants demonstrates that PES is clearly attractive to a sufficient number of landholders. Yet this confounds the ability to better understand achievement of PES-related socioeconomic objectives, or even how such objectives should be defined.

Despite debate in development literature about appropriate tactics for ameliorating poverty, there is consensus that financial assistance alone will not yield success. Rather, a combination of investments in health services, education and infrastructure is essential (e.g., U.N. Millennium Village projects). Costa Rica has long been recognized for its extensive social services and emphasis on education. FONAFIFO is gearing up to increase collaboration with civil society to enhance outreach and capacity-building for marginalized groups (World Bank 2006). If PES is to better the quality-of-life for the rural poor, perhaps an explicit, formal design linking PES

participation with these broader well-being institutions and mechanisms is needed in the next phase of implementation.

4. Conclusions

Land use change has significant ecological impacts, and is second only to electricity/heat generation as a source of global greenhouse gases (Baumert et al., 2005). To address forest-related land use change, Costa Rica implemented a novel, market-based conservation strategy. PES—coupled with a long-standing commitment to address deforestation and biodiversity erosion—has substantially transformed the externalized values of forests. Costa Rica designed a conceptually-sound PES finance mechanism and set an example for other countries to follow. In fact, PES land now rivals the much-lauded Costa Rican national park system in area, illustrating how significantly this strategy affects private-property land use.

We reviewed Costa Rica’s experience with PES; the lessons learned range from logistical to scientific. Even when scheme design is sound (e.g. Costa Rica’s reliance on a polluter pays- inspired fuel tax to fund PES), implementation can fall short of the intended policy (e.g., co-optation for other uses). This case study illustrates that many challenges arise for PES schemes due to the complexity of working with large numbers of diverse stakeholders in an ever-changing economic context. We have made suggestions regarding how Costa Rica’s scheme design might be enhanced (Table 2) as it embarks on a new phase of PES implementation through the “Mainstreaming and Scaling Up PES” project with World Bank support. These include decoupling the financing of

monitoring from the monitoring itself, strategically targeting PES land for both ecological and social objectives, and laddering contracts over different time spans to enhance the continuity of ecosystem service provision. While each of these changes offer benefits and drawbacks, their careful consideration and use can promote future PES-based conservation in Costa Rica while providing valuable lessons for emerging programs.

Identified Issue	Category/goal	Action	Benefits	Challenges
Institutional forestry bias	Program administration	Change internal structure of FONAFIFO's board; involve other environment-related professionals in PES design & monitoring	"Forestry-sector bias" has helped develop small plantations, reducing pressure on forests	"Forestry-sector bias" provides equal funding for plantations, which do not the ecosystem services of natural forests
Monitoring too closely tied to compensation	Program administration	Have multiple <u>regentes</u> monitor a contract over its lifetime (e.g. random assignment each year)	More transparent reporting of success & failure	Need to develop feasible way to restructure <u>regente</u> payments from the proposed "pooled fund"
Amount of payment	Opportunity cost	Redefine payment amounts to be more sensitive to economic fluctuations; consider "contract laddering"	Possibly greater perception of fairness to landowners, and ensure longer-term service provision	Difficulty of PES competing with high value land uses; higher payment levels could mean less total land and ecosystem services enrolled
Free riding and identifying long-term funding sources	Equitable financing; Sustainable financing	Eliminate free riding by international & local beneficiaries; move toward more sustainable financing sources	Fairer & more sustainable program financing; being implemented at national level	Lack of political will to require fair international payments for global ecosystem services
Level of service	Bundling, Spatial	Target payments to	Could improve program	Could reduce

provision variable and loosely linked to modality	targeting	areas of high ecosystem service values, differentiate payments based on services delivered, modalities, regions of the country	efficiency and total ES provision	participation by the poor; auctions must be carefully designed to avoid strategic bidding
Level of service provision variable and loosely linked to modality	Spatial targeting	Reverse auctioning to identify opportunity costs for landowners to participate	Could improve program efficiency and total ES provision	Could reduce participation by the poor; auctions must be carefully designed to avoid strategic bidding
Poverty alleviation debatable goal of PES	Socioeconomic objectives	Reduce transaction costs and other barriers to entry for poor households	Greater participation for poor	May reduce total delivery of ecosystem service benefits
Poverty alleviation debatable goal of PES	Socioeconomic objectives	Further research into why poorer households do not participate in PES, and if PES is appropriate for poverty alleviation	Better identify potential barriers to entry for poor households	Requires rigorous, unbiased research and political will to act on recommendations

Table 3-2. Summary of issues and recommendations for Costa Rica's PES program

Rodriguez et al., (2006) stress the need to critically consider tradeoffs resulting from competing ecosystem services. Ecosystem management institutions like PES schemes are influential in tipping this balance. Our review of Costa Rica's PES program highlights institutional design tradeoffs affecting the nature, amount and geographic arrangement of ecosystem service provision. For example, larger PES contracts are advantageous for institutional efficiency and for meeting ecological scale-dependency in ecosystem service provision. Yet this translates into fewer PES contracts and diminished program equity. Another example entails allocation of PES contracts across production and conservation modalities of PES. Forestry initiatives may contribute to rural development and relieve timber pressure on natural forests, while protection of natural forest generally yields a greater bundle of ecosystem services. FONAFIFO's institutional forestry bias is arguably appropriate for the current mix of modalities, but may be inadequate to administer modalities added in future iterations of the PES program. This underscores the importance of feedback mechanisms in PES design so that the institutional arrangements may evolve appropriately.

One critical tradeoff in Costa Rica's current PES scheme design occurs between maximizing ecosystem services and achievement of socioeconomic objectives. Providing socially-optimal levels of ecosystem services and raising the quality-of-life for the rural poor are both components of the PES program. To manage this tradeoff consciously, Costa Rica might explicitly define quality-of-life indicators and implement ecologically-rigorous spatial targeting criteria, as we have suggested here. We have also identified steps to improve program efficiency—conserving more land through tiered payments that

spatially target areas of high ecosystem services, combined with reverse auctioning to conserve land at a rate consistent with landowners' opportunity cost. Reverse auctioning can reduce rents to landowners, yet for the poor, such rents could constitute valuable supplemental income. Alternatively, if benefiting the poor is the program's primary goal, PES would likely achieve lower overall levels of ecosystem service provisioning. Ecological economics seeks a sustainable economic scale, fair distribution of resources, and efficient allocation (Daly and Farley, 2004). These goals are typically ranked in that order with the understanding that maintaining justice and efficiency is impossible in the absence of sufficient natural capital to support the human economy. While some level of "win-win" may be possible between the numerous tradeoffs that PES entails, a more decisive PES design is required.

The tradeoffs we highlight do not represent design flaws per se. Rather, they are inherent elements of any PES system and serve as junctures for critical decision-making on the part of the implementing agencies and supporting constituencies. We have pointed out the achievements and challenges in Costa Rica's present PES scheme, providing insight useful to other programs in evaluating PES design choices. As this case study illustrates, PES is a pliable conservation tool that can be molded to fit specific contexts and meet certain objectives; but tradeoffs should be anticipated and dealt with both a priori and iteratively for the long term success of environmental service provision. Viable PES schemes hinge on innovation and Costa Rica is well-positioned to begin pilot testing some of the more-nuanced design elements we have proposed here.

References

- Amador, J.A., Laporte, S., Chacon, R.E., 2000. Cuenca del Rio Arenal: analisis del los eventos Nino de los anos 1992-93, 1994-95 y 1997-98. *Topicos Meteorologicos y Oceanograficos* 7(1), 1-20.
- Ando, A., Camm, J., Polasky, S., Solow, A., 1998. Species distributions, land values, and efficient conservation. *Science*, 279: 2126-2128.
- Arroyo-Mora, J. P., Sanchez-Azofeifa, G. A., Rivard, B., Calvo, J. C., Janzen, D. H., 2005. Dynamics in landscape structure and composition for the chorotega region, costa rica from 1960 to 2000. *Agriculture Ecosystems & Environment* 106, 27-39.
- Avalos, A.R., 2007. Ice suspende coretes de electricidad en todo el pais. *La Nacion*. Sabado 5 de mayo. Available at http://www.nacion.com/ln_ee/2007/mayo/05/pais1085589.html, Accessed on May 5, 2007.
- Ayuk, E. T., 1997. Adoption of agroforestry technology: The case of live hedges in the central plateau of Burkina Faso. *Agricultural Systems* 54,189-206.
- Babcock, B.A., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1996. The economics of a public fund for environmental amenities: A study of CRP contracts. *American Journal of Agricultural Economics*, 78: 961-971.
- Babcock, P.G., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1997. Targeting tools for the purchase of environmental amenities. *Land Economics*, 73 (3): 325-339.
- Baumert, K., Herzog, T., Pershing, J., 2005. Navigating the numbers: greenhouse gas data and international climate policy. 122 pages, World Resources Institute, Washington D.C., USA.
- Beier, C., Patterson, T., in review. Targeted social-ecological vulnerability at the landscape scale: ecosystem services, social importance and disturbance. Submitted to *Ecosystems*.
- Bengston, D.N., Youn, Y.C., 2006. Urban Containment Policies and the Protection of Natural Areas: The Case of Seoul's Greenbelt. *Ecology and Society*, 11: 3.
- Berentsen, B.M., Hendriksen, A., Heijman, W., van Vlokhoven, H., 2007. Costs and benefits of on-farm nature conservation. *Ecological Economics*, 62, 571-579.
- Biesanz, R., Biesanz, K.Z., Biesanz, M.H., 1982. *The Costa Ricans*. Waveland Press, Prospect Heights, IL.

Brennan, A., 1995. Ethics, ecology and economics. *Biodiversity and Conservation*, 4 (8): 798-811. Brockett C., Gottfried, R., 2002. State policies and the preservation of forest cover: lessons from contrasting public-policy regimes in Costa Rica. *Latin American Research Review*, 37(1), 7-40.

Bruijnzeel, L.A., 2004. Hydrological functions of tropical forests: Not seeing the soil for the trees? *Agriculture, Ecosystems, and Environment*, 104, 185-228.

Bruijnzeel, L.A., 2006. Cloud forests, hydrology and payment for Ecosystem Services in Costa Rica. Available at http://www.iucn.org/themes/cem/news/newsletter/2006/cem_newsletter03_2006.htm, accessed on September 12, 2007.

Castillo, E.A., 2006. Proyecto Ecomercados: Consultoria Para Actualizacion de la Propuesta Technica de Ordenamiento Territorial Con Fines de Conservacion de Biodiversidad en Costa Rica (GRUAS II).

Chomitz, K. M., Brenes, E., Constantino, L., 1999. Financing environmental services: The costa rican experience and its implications. *Science of the Total Environment* 240, 157-169.

Chomitz, K.M., Fonseca, G.A.B., Alger, K., Stoms, D.M., Honzák, M., Landau, E.C., Thomas, T.S., Thomas, W.W., Davis, F., 2006. Viable reserve networks arise from individual landholder responses to conservation initiatives. *Ecology and Society* 11, 40.

CIA, 2007. The World Fact Book – Costa Rica. Available at <https://www.cia.gov/cia/publications/factbook/geos/cs.html>, accessed on May 2, 2007.

CIFOR, 1999. Your subsidies are my incentives. POLEX. Available at <http://www.cifor.cgiar.org/Publications/Polex/polexdetail.htm?pid=19>, accessed on December 18, 2006.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253-260.

Costanza, R., 2001. Visions, Values, Valuation, and the Need for an Ecological Economics. *BioScience* 51 (6), 459-468.

Costanza, R. and Farley, J., this issue. Introduction: Theory and Practice of Payments for Ecosystem Services: The Heredia Declaration. *Ecological Economics*.

Daly, H.E. and Farley, J., 2004. *Ecological Economics: Principles and Applications*. Island Press, Washington, DC.

De Camino, R., Segura, O., Arias, L.G., Pérez, I., 2002. *Costa Rica: Forest Strategy and the Evolution of Land Use*. World Bank Evaluation Country Case Study. Series 148. The World Bank, Washington, DC.

Estado de la Nacion, 2006. *Duodécimo informe estado de la nacion en desarrollo humano sostenible*. Programa Estado de la Nacion, San Jose, Costa Rica. (ISBN: 9968-806-37-4).

Farley, J., Aquino, A., Daniels, A., Lee, D., Krause, A., this issue. Global mechanisms for sustaining and enhancing PES systems. *Ecological Economics*.

Ferraro, P.J., 2001. Global habitat protection: Limitations of development interventions and a role for conservation performance payments. *Conservation Biology* 15 (4), 990-1000.

García, R., 1996. *Propuesta tecnica de ordenamiento territorial con fines de conservacion de biodiversidad: protyecto GRUAS*. Ministerio del Ambiente y Energía (MINAE) and sistema Nacional de Areas de Conservacion (SINAC), Costa Rica.

Godoy, R. A., 1992. Determinants of smallholder commercial tree cultivation. *World Development* 20, 713-725.

Grieg-Gran, M., Porras, I., Wunder, S., 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development* 33, 1511-1527.

Kosoy, N., Martinez-Tuna, M., Muradian, R., Martinez-Alier, J., 2007. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. *Ecological Economics*, 61 (2-3), 446-455.

Krysiak, F.C., 2006. Entropy, limits to growth, and the prospects for weak sustainability. *Ecological Economics*, 58(1): 182-191.

Landell-Mills, N., Porras, I.T., 2002. *Silver bullet or fool's gold? A global review of markets for forest environmental services and their impact on the poor*. International Institute for Environment and Development, London.

Lara, S., Barry, T., Simonson, P., 1995. *Inside Costa Rica—The essential guide to its politics, economy, society and environment*. Resource Center Press. Albuquerque, New Mexico, USA.

Latacz-Lohmann, U., van der Hamsvoort, C., 1997. *Auctioning conservation contracts: A*

theoretical analysis and an application. *American Journal of Agricultural Economics*, 79 (2): 407-418.

Latacz-Lohmann, U., Schilizzi, S., 2005. Auctions for conservation contracts: A review of the theoretical and empirical literature. Report to the Scottish Executive Environment and Rural Affairs Department. Project No. UKL/001/05.

Lutz, E., Daly, H., 1991. Incentives, regulations and sustainable land use in Costa Rica. *Environmental and Resource Economics*, 1, 179-194.

Marsik, M., Waylen, P., 2006. An application of the distributed hydrologic model CASC2D to a tropical montane watershed. *Journal of Hydrology* 330, 481-495.

Miranda, M., Dieperink, C., Glasbergen, P. 2006. Costa Rican environmental service payments: the use of a financial instrument in participatory forest management. *Environmental Management* 38, 562-571.

Mulder, M., Coppolillo, P. 2005. *Conservation: Linking Ecology, Economics and Culture*. Princeton University Press, Princeton, NJ.

Naidoo, R., Ricketts, T.H., 2006. Mapping the economic costs and benefits of conservation. *PLOS Biology*, 4 (11): 2153-2164.

Neupane, R. P., Sharma, K. R., Thapa, G. B., 2002. Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. *Agricultural Systems* 72, 177-196.

O'Grady, M.A. 2006. Costa Rican poverty fighter. *The Wall Street Journal*. May 5, 2006.

Olson, M., 1965. *The Logic of Collective Action*. Harvard University Press, Cambridge, MA.

Oviedo, E., 2006. Estado paga poco por conservar bosques. *La Nacion*, 20 de noviembre.

Pagiola, S., Arcenas, A., Platais, G., 2005a. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. *World Development* 33, 237-253.

Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ramirez, E., Rosales, M., Ruiz, J. P., 2005b. Paying for biodiversity conservation services - Experience in Colombia, Costa Rica, and Nicaragua. *Mountain Research and Development* 25, 206-211.

Pagiola, S., 2006. Payments for environmental services in Costa Rica. MPRA Paper No. 2010. Revised version of a paper presented at the ZEF-CIFOR workshop on Payments for

environmental services: Methods and design in developing and developed countries, Titisee, Germany, July 15-18, 2005.

Polasky, S., Camm, J.D., Garber-Yonts, B., 2001. Selecting biological reserves cost-effectively: An application to terrestrial vertebrate conservation in Oregon. *Land Economics*, 77 (1): 68-78.

Randall, A., 1993. The Problem of Market Failure. In: *Economics of the Environment*. R. Dorfman and N. Dorfman, eds. Norton, New York.

Rodriguez, J. P., Beard, T. D., Bennett, E. M., Cumming, G. S., Cork, S. J., Agard, J., Dobson, A. P., Peterson, G. D., 2006. Trade-offs across space, time, and ecosystem services. *Ecology and Society* 11, 28.

Rojas, M., Aylward, B., 2003. What are we learning from experiences with markets for environmental services in Costa Rica? A review and critique of the literature. International Institute for Environment and Development, London.

Salzman, J., Ruhl, J.B., 2002. Paying to protect watershed services: Wetland banking in the United States. In: Pagiola, S. and Bishop, J. (eds). *Selling Forest Ecosystem Services: Market-based mechanisms for conservation and development*. Earthscan, London.

Salzman, J., 2005. Creating markets for ecosystem services: Notes from the field. *New York University Law Review*, 80 N.Y.U.L. Rev. 870.

Samuelson, P.A., 1954. The pure theory of public expenditure. *The review of Economics and Statistics* 36 (4): 387-389.

Sanchez-Azofeifa, G., Harriss, R. C., Skole, D. L., 2001. Deforestation in Costa Rica: A quantitative analysis using remote sensing imagery. *Biotropica* 33, 378-384.

Sanchez-Azofeifa, G. A., Daily, G. C., Pfaff, A. S. P., Busch, C., 2003. Integrity and isolation of costa rica's national parks and biological reserves: Examining the dynamics of land-cover change. *Biological Conservation* 109, 123-135.

Sierra, R., Russman, E., 2006. On the efficiency of environmental service payments: A forest conservation assessment in the Osa Peninsula, Costa Rica. *Ecological Economics* 59 (1): 131-141.

Sills, E., Hartshorn, G., Ferraro, P., and Spergel, B. 2005. Evaluation of the World Bank-GEF ecomarkets project in Costa Rica. Blue Ribbon Panel Report. North Carolina State University, Durham, North Carolina.

Steed, B., 2003. Completing the mosaic: the conservation of private lands in Costa Rica.

Journal of Land, Resources, and Environmental Law 173, 173-180.

Stoms, D.M., Chomitz, K.M., Davis, F.W., 2004. TAMARIN: a landscape framework for evaluating economic incentives for rainforest restoration. *Landscape and Urban Planning*, 68: 95-108.

Stoneham, G., Chaudri, V., Ha, A., Strappazon, L., 2003. Auctions for conservation contracts: An empirical examination of Victoria's BushTender trial. *Australian Journal of Agricultural and Resource Economics*, 47 (4): 477-500.

Szentandrasi, S., Polasky, S., Berrens, R., Leonard, J. 1995. Conserving biological diversity and the conservation reserve program. *Growth and Change*, 26: 383-404.

Tietenberg, T.H., 1989. Economic instruments for environmental regulation. *Oxford Review of Economic Policy*, 6 (1): 17-33.

Watson, V., Cervantes, S., Castro, C., Mora, L., Solis, M., Porras, I.T., Cornejo, B., 1998. Making Space for Better Forestry: Costa Rica Country Study. Policy that Works for Forests and People Series No: 6. International Institute for Environment and Development: London.

World Bank, 2000. Costa Rica Ecomarkets Project. Project Appraisal. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

World Bank, 2006. Scaling up and mainstreaming payment for environmental services in Costa Rica. Project Appraisal. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

World Bank. 2007. Key Development Data & Statistics. Available at <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/>, accessed May 2, 2007.

Wunder, S., 2005. Payments for environmental services: Some nuts and bolts. CIFOR Occasional Paper No. 42. Center for International Forestry Research, Jakarta, Indonesia.

Wunder, S., 2007. The Efficiency of Payments for Environmental Services in Tropical Conservation. *Conservation Biology*, 21(1): 48-58.

Wünscher, T., Engel, S., Wunder, S., 2007. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. Presented at the Workshop on Carbon Sequestration in Agriculture and Forestry conference, Thessaloniki, Greece, June 27, 2007.

Zbinden, S., Lee, D. R., 2005. Paying for environmental services: An analysis of participation in Costa Rica's PSA program. *World Development* 33, 255-272.

CHAPTER 4: CONSERVATION AND POVERTY ALLEVIATION IN COSTA RICA'S PES PROGRAM: FRIEND OR FOE?

Chapter Summary

Costa Rica is one of the first countries to institute a national payment for ecosystem services (PES) program. A market-based mechanism, landowners are paid per hectare to protect, reforest, or sustainably manage forest ecosystems. While the primary goal of PES is conservation, the potential exists for synergy between development, poverty alleviation and conservation objectives in such programs. In fact, one of the originally stated goals of Costa Rica's PES program is to benefit small and medium landowners and contribute to rural development, making poverty alleviation an implicit aim of the program. However development demands and other land uses often result higher market value than the payment value, which can lead to substantial program attrition rates or difficult choices for poor participants. The purpose of this study is to gain greater insight into the factors that promote or inhibit participation of poor landowners in Costa Rica's PES program through qualitative research that examines their perceptions and attitudes about the project. Twenty-four landowners in the Central Volcanic Cordillera Region of Costa Rica were interviewed to investigate overall thoughts about the program, implications on social capital, the role of ecological literacy, and barriers to participation. Three non-participants were also interviewed for comparison purposes. Analysis reveals that many participants belong to the program despite the small amount of compensation. Social capital may be adversely affected in the community, due to negative views of the

program by non-participants who do not believe the program is beneficial to individuals or the community. Small landowners often feel isolated and lacking support from government institutions, with major hindrances or barriers of participation including deficiencies of information and guidance, lack of targeted recruitment and high transaction fees. This research adds to the emerging literature on PES and poverty alleviation and will guide better development and endurance of future PES projects, particularly focusing on issues of equity, qualitative understanding of program design and poor landowner participation and retention.

1. Introduction

Payments for environmental services (PES) programs have emerged as a promising instrument that incorporates paying private landowners for forest ecosystem conservation. Earlier conservation schemes, recognizing the importance of developing people-based programs, explicitly focused on poverty alleviation as the main means for environmental protection and conservation, resulting in little change in tropical land use (Brandon et al., 1998; Sayer, 1995; Wunder, 2005). PES, on the other hand, recognizes the institutional-design tradeoffs inherent in any approach and attempts to balance competing interests such as efficiency versus equity in participation; conservation versus production approaches; and balancing maximum provision of services with socioeconomic goals (Daniels et al., in prep). PES programs have become the new golden child of forest conservation: a 2002 review identifying approximately 287 ongoing and proposed projects globally (Landell-Mills and Porras, 2002). Projects

design varies from protection (that prohibits any use of the area), to sustainable wood production, to replanting forests.

A market-based mechanism, PES in Costa Rica focuses on the provision of four types of ecosystem services: landscape beauty, water quality and regulation, carbon and biodiversity (Grieg-Gran et al. 2002). Financing for supplying those services can take many forms. For example, tourism providers, particularly those associated with ecotourism, are growingly investing in communities to maintain forests for scenic views (Pagiola et al, 2005b). Watershed protection commonly involves upstream farmers being paid for retaining and restoring riparian buffer zones by downstream users (Chichilnisky and Heal, 1998). Global carbon markets and other initiatives (such as a Northern organization paying farmers in developing countries to reforest and maintain their land) have become popular channels to advance carbon sequestration and storage from forests (Grieg-Gran et al. 2002, Wunder, 2005). Recognizing the need for and establishing biological corridors and similar other mechanisms can also attract greater funding opportunities that promote biodiversity conservation (Zilberman et al., 2006).

Conservation programs have always faced hard tradeoffs between increasing land use demands, limited funding and conflicting interests. By placing PES in the market realm and engaging private landowners, this approach transparently attempts to mitigate these conflicts through compensation (Wunder, 2005). However, developing countries still face harsh socioeconomic realities, provoking program design to couple conservation approaches with poverty reducing mechanisms. While PES programs are primarily intended to improve natural resource management, there has been much discussion in the

literature about the contributions of such initiatives toward poverty alleviation (Grieg-Gran et al., 2005; Landell-Mills and Porras, 2002; Miranda et al., 2003; Pagiola et al., 2005a).

Indeed, the potential exists for synergy between development, poverty alleviation and conservation objectives in PES programs. In fact, one of the originally stated goals of Costa Rica's PES program is to benefit small and medium landowners and the government asserts that the program has positively contributed to rural development, making poverty alleviation an implicit aim of the program (Article 1 of Ley 7575). Yet reviews of Costa Rica's and other similar projects reveal that conservation and poverty alleviation can take divergent paths (Chomitz et al., 2006; Grieg-Gran et al., 2005; Landell-Mills and Porras, 2002; Miranda et al., 2003). Although the law itself targets rural populations, closer examination reveals mixed results. At the national level, the majority of PES participants are small and medium landholders (Sills et al., 2005). Nonetheless, regional studies found that PES participants tend to have higher off-farm incomes, larger properties and higher levels of education than otherwise equivalent non-participants (Zbinden and Lee, 2005).

This paper seeks to examine, in-depth, the experiences of poor landowners in Costa Rica's PES. It begins with a brief review of the history of Costa Rica's program. It employs qualitative research, through semi-structured interviews, to extract textured and illuminating information that surveys and other quantitative methods cannot provide. The results impart important insights into the real experiences of poor landowners and the social and economic decision factors that effect participation in the program. This

research adds to the emerging literature on PES and poverty alleviation and will guide better development and endurance of future PES projects, particularly focusing on issues of equity, qualitative understanding of program design and poor landowner participation and retention.

2. A Brief History of Costa Rica's PES

Costa Rica enjoys an impressive reputation for sound conservation management. The country has worked hard to develop a system of national parks and reserves, reversing deforestation trends of 4.2% per year between 1986 and 1991 (Sanchez-Azofeifa et al., 2001). The nation's forestry policies have evolved over several decades, beginning with the implementation of various governmental subsidies such as income tax and soft credits, tradable tax vouchers, cost offsets and municipal forestry funding (CIFOR, 1999; Daniels et al., in prep; Zbiden and Lee, 2004). PES evolved out of the desire to achieve the social goal of making forestry programs more equitable for private landowners (Segura, 1992). While its precursors reforested approximately 109,000 hectares between 1979-96 and today national parks and private reserves cover more than one quarter of the country, deforestation in non-protected areas continue to threaten these important gains (Sanchez-Azofeifa et al., 2003; World Bank, 2000). With the passage of an innovative new forestry law (No. 7575, 4-16-96, Gaceta 72, Alcance 21), the PES system brings forest conservation into the market, transferring it from government subsidies (which were eliminated by the restructuring of a World Bank loan) to "polluter pays" and "beneficiary pays" frameworks (Camacho et al., 2002; Waston et al., 1998).

Today in Costa Rica, landowners can belong to one of several modalities in PES to provide the four aforementioned ecosystem services: 1) protection of existing forest, with no activity permitted 2) reforestation, via plantations 3) natural forest regeneration and 4) agroforestry systems, which allows sustainable timber harvesting (Gaceta 51, 3-13-07). See Table 4-1 for an overview of modalities. Payment is made per hectare and the amount is uniform for all landowners within the modality. Participants join the program for varying lengths of time, from five years for conservation to up to 15 years for reforestation, and receive payment throughout that period of inscription (FONAFIFO, 2006). The property title lists program conditions, ensuring that if a property is sold during the contract tenure, there will still be program compliance (Daniels et al., in prep). PES is administered by the National Forestry Financing Fund (FONAFIFO), a semi-autonomous arm of the Ministry of Environment and Energy (MINA). MINAE publishes the annual budget for PES and how funds will be distributed across the modalities as well as guidance with how to designate priority zones for each method (Castillo, 2006; García, 1996).

The first step to joining PES is to demonstrate land ownership through possession of the property title. Participants then must work with a professional forester, or regent, to craft a formal forest management plan that meet the terms of the modality (Article 20, Ley 7575). Signs must be posted on the property to indicate that hunting, fire, and logging are prohibited and landowners are expected to regularly monitor their land to ensure these activities are not occurring. Site visits are performed annually by the regent

to ensure contract fulfillment (Article 10.2, Gaceta 51, 3-13-07; Article 21, Ley 7575). Often participants work with regents supplied by the PES program; payment is thus initially deducted from payment. Private foresters can also be contracted, with the landowner paying directly for those services.

Modality	Conditions	Payment	Priority
Forest Protection	<ul style="list-style-type: none"> Between 2 and 300 hectares enrolled Maximum 600 hectares (within indigenous areas) 	<ul style="list-style-type: none"> \$64 per hectare per year (provided over five year period and renewable) 	<ul style="list-style-type: none"> Potential and existing biological corridors Protection of designated hydrologic resources Unpurchased protected areas Locations in cantons with MIDEPLAN Social Development indexes lower than 40%
Reforestation	<ul style="list-style-type: none"> Between 1 and 300 hectares enrolled Maximum 50 hectares enrolled Minimum 2 hectares enrolled 	<ul style="list-style-type: none"> \$816 per hectare over ten-year period 	<ul style="list-style-type: none"> “High potential” forest plantations Areas with threatened species Pastures defined as Kyoto lands Projects under natural regeneration for at least one year
Natural Forest Regeneration	<ul style="list-style-type: none"> Minimum 2 hectares enrolled 	<ul style="list-style-type: none"> \$41 per hectare per year (provided over five year period and renewable) 	<ul style="list-style-type: none"> None specified
Agro-forestry Systems	<ul style="list-style-type: none"> Minimum 350 trees, maximum trees per participant Maximum 336,000 trees per joint project, cooperative or indigenous reserve Specific requirements per hectare and km². 	<ul style="list-style-type: none"> \$1.30 per tree (provided over three year period) 	<ul style="list-style-type: none"> Projects with organizations with FONFOFIFO agreements Land as described in Ministry of Agriculture and Farming Report, 1995 Areas with specific agreements with FONOFIFO
Forest Management	<ul style="list-style-type: none"> Criteria determined by conservation area 	<ul style="list-style-type: none"> ~\$343 per hectare (provided over five year period) 	<ul style="list-style-type: none"> Priority determined by conservation area

Table 4-1: Modality Descriptions (adapted from Daniels et al., in prep)

3. Socioeconomic Considerations in PES

The importance and contribution of healthy ecosystems to human well-being and poverty reduction has gained increasing awareness and attention in recent years. Perhaps the most significant example of this is the Millennium Ecosystem Assessment (2005), launched by then U.N. Secretary-General Kofi Annan in June 2001, to provide a global, integrated evaluation of the current changes and consequences occurring within ecosystems. The results demonstrate that 60% (15 of 24) of ecosystem services have been degraded or used unsustainably, with the poor disproportionately bearing the effects, exacerbating poverty and social conflict (MA, 2005). This underscores the need to simultaneously address environmental, social and economic needs in conservation and poverty alleviation programs. In fact, despite debate in development literature about appropriate tactics for sustainable development and conservation-friendly management, there is consensus that financial assistance alone will not yield success (Ayuk, 1997; Berentsen et al., 2007; Godoy, 1992; Neupane et al., 2002). Rather, a combination of investments such as health services, education, outreach and communications, environmental protection and infrastructure is essential (Stiglitz, 2006). Closer scrutiny of the program will shed light on if PES is an effective instrument to positively impact poor participants.

Land Ownership and Tenure and Transaction Costs

In order to take part in the program, all participants must prove landownership via a title. However, usually the poorest citizens do not own the land or have insecure land

holdings, thus placing a sometimes insurmountable barrier in the way of participation (Landell-Mills and Porras, 2002; Miranda et al., 2003; Pagiola, 2002). Responding to previous research, FONAFIFO has changed its policies to largely circumvent this barrier by administering private funds to participants without needing land titles (Pagiola, 2007). Nevertheless, the landless poor, one of the most vulnerable groups, are still precluded from PES, since they do not own or have access to land. Separate initiatives should be taken to focus specifically on this group that fall outside the scope of PES.

Transaction costs can be prohibitive to inscription as well. Participants are required to demonstrate compliance with other governmental requisites, such as being up-to-date with payments to the national health system and having their local taxes in order to belong to the program (Miranda et al., 2003; Pagiola, 2007). Members are also obligated to develop a management plan with a certified forest engineer. This can be accomplished by contracting directly with non-governmental organizations (NGOs) that assist people with program participation such as FUNDECOR (Fundación de la Cordillera Volcánica Central, in the central cordillera region). Fees taken by NGOs are usually a percentage of the total payment (25% the first year, 10% each additional year), which can disproportionately burden small and/or poor landowners.

Some of these barriers have been eased through FONAFIFO's efforts. For instance, FONAFIFO has streamlined their information with other government agencies' databases to remove the burden of individuals having to prove their compliance status (Pagiola, 2007). Additionally, participants now have the option of contracting private foresters to provide technical assistance such as drafting management plans and

monitoring, which often proves to be cheaper than the fee for the NGOs (personal communication, 2007). FONAFIFO has recently taken another step to promote participation by permitting small landowners to form associations and enter into the PES under one contract as a joint entity in order to reduce transaction costs (Daniels et al, in prep; Miranda, 2003; Pagiola 2007). While these actions go far in reducing impediments, transaction fees have not been totally eliminated and may prove unduly burdensome to poorer landowners.

Ecological Literacy

As the program evolves, new barriers related to ecological literacy may also emerge to prevent participation by Costa Rica's poorest residents. While the role of ecological literacy in conservation and development programs is not adequately understood, preliminary evidence suggests that ecological literacy can play an important role in successful participation and program outcomes (Becker, 2006; Beirele and Cayford, 2002; Hsu and Roth, 1998). Disinger and Roth (1992), considered to be the founding fathers of ecological literacy, offer a widely accepted definition of ecological literacy: "[the] capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems...defined in terms of observable behaviors...knowledge of key concepts, skills acquired, disposition towards the issues..." (p.3). This definition outlines a complex relationship between environmental understanding and behavior. In fact, to further

explicate this multifaceted relationship, the National Project for Excellence in Environmental Education delineates four elements of ecological literacy:

- 1) knowledge of environmental processes and systems
- 2) skills for understanding and addressing environmental issues
- 3) questioning and analysis skills
- 4) personal and civic responsibility

(EETAP, 2004).

Although the fact that there is a waiting list to join the program is touted as a mark of the program's success, it also signifies that less, if any, recruitment on the part of FONAFIFO's and supporting NGOs (personal communication, 2007). Initially NGOs such as FUNDECOR went door-to-door to inform potential participants about the program; now there is limited (or no) outreach for new participants. Furthermore, some regions in Costa Rica have indicated that they give priority to those members who have already demonstrated some knowledge of how the program works and the importance of ecosystems, or have a high level of ecological literacy, in order to reduce time and educational investments (personal communication, 2007). Both of these practices may affect poorer landowners more, as they tend to have less access to information and lower educational and literacy rates.

Social Capital

Social capital is considered to be the connections that individuals form from strong social networks and "the norms of reciprocity and trustworthiness that arise from

them” (Putnam, 2000, p.19). Social capital is progressively being viewed as a concrete, tangible realization that can increase individual and collective well-being (Putnam, 2000). Proponents assert that higher levels of social capital are linked with enhanced health, advanced educational achievement, better-quality employment outcomes and lower crime rates (National Statistics, 2003). It also has the potential to have a synergistic affect on communities to engaging in environmental management, particularly through forming social norms. For example, Mackenzie-Mohr (2000) found that asking participating families in a community composting program to display a decal announcing their involvement increased both compliance with those families and augmented inscription rates. Previous research suggests that social capital is often developed through PES due to institutional building and community support (Grieg-Gran et al., 2005; Hope et al., 2005; Miranda et al, 2003; Pagiola et al., 2005; Rosa et al., 2003; Wunder, 2005). While this can result in higher membership rates and potentially have other beneficial affects on poor participants, more research is needed to determine if PES and social capital are positively correlated.

The discussion above illuminates considerations that must taken into account when designing a PES program to incorporate social goals as well. However, it is also critical to understand the experience of poor landowners once they are enrolled in the program, to understand the effects of participation on their lives. The purpose of this study is to gain greater insight into the factors that promote or inhibit participation of poor landowner participants in Costa Rica’s PES program.

Other Considerations

Aside from the aforementioned discussion, there may be other reasons for not participating in the PES programs. The philosophy behind the program – that people should be paid for preserving nature – sets up a new set of rules and norms than those previously established. Residents may not agree with the precedent that PES establishes, or may have trouble understanding these new rules and norms. As both social capital and social network analysis literature reveals, the relationships between participants and non-participants can play a big role in how, if at all, this change in rules and norms is accepted (Breiger, 2004; Krebs, 2007).

3. Methods

The inherently shared nature of ecosystems necessitates in-depth comprehension of the multiple perspectives people hold about them. Hence, this research examines the qualitative aspects of PES in an attempt to uncover those more intangible - but quite relevant and important - variables that affect project outcomes, not effectively measured through surveys or other quantitative means. Qualitative research seeks to gain greater insight to understanding social phenomena, including understanding perspectives and attitudes that underlie behavioral patterns (Marshall and Rossman, 1999). It is especially useful to understand the way that individuals experience a particular process and how they interpret and ascribe meaning to this occurrence (Morse and Richards, 2002).

Case study methodology offers purposive, situational or interrelated descriptions of phenomenon, connecting practical complex events to theoretical abstractions (Stake, 1995). Costa Rica was chosen as a case study for several reasons. While the country boasts a 4th highest ranking in the 2007 Human Development Index among Latin American countries, approximately 33% of rural households lived below the poverty line in 2006 (Estado, 2008). Therefore designing conservation programs that also aim to achieve socioeconomic development goals is still a country priority (FONAFIFO, 2006). Costa Rica's PES began in its present form in 1996, evolving throughout this decade. Participants, therefore, enjoy a long familiarity with PES, either through inscription or general knowledge about the program, which has been well-publicized throughout the country (Pagiola, 2007).

The Central Volcanic Cordillera Region includes the capital, San José; with more than half of the nation's residents, it is the most populated area. It boasts one of the highest forest covers in the country and is home to many of Costa Rica's National Parks (FUNDECOR, 2008). Yet seventeen percent (17%) of its rural population lives in poverty (Estado, 2008). Unlike other regions, participants in the PES program have support from FUNDECOR, which facilitates access to information about the program (personal observation, 2007). FUNDECOR is a private non-profit agency founded in 1989 whose mission is to protect and develop the forests in its coverage area (FUNDECOR, 2008). PES is one of several programs FUNDECOR oversees, and the organization receives financing from revenue for technical services provided to PES participants (such as designing a property's management plan), as well as managerial fees

from other programs, such as a wood certification program (FUNDECOR, 2008). Due to its population density, PES participants in this region tend to be well-off urban dwellers with substantial nonagricultural incomes (Miranda et al., 2003; Ortiz Malavasi et al., 2003). Therefore, it is even more critical to understand why a small minority of rural poor landowners would participate in PES. Approximately 550 families in PES work with FUNDECOR (personal communication, 2007).

Within this Central Volcanic Cordillera Region, Puerto Viejo de Sarapiquí and surrounding towns, located in the north east of the country and bordered by Nicaragua in the north, were chosen as the study area due to its rural poor population. It is also an important environmental area, as it hosts the La Selva Biological Field Station of the Organization for Tropical Studies, a global center for research in tropical biology. The region also boasts high amounts of biodiversity (McDade et al., 1994). Thanks to the Sarapiquí River, which flows through the region, as well as the climate, the area is ideal for growing banana, coffee, cardamom, cacao, corn and, increasingly, pineapple. Cattle and dairy production are also predominate in the region. Due to its wealth of natural resources, the area is also progressively growing more popular as a tourist destination (McDade et al., 1994). See Figure 4-1 for a map of the area.

Purposeful sampling, using information-rich cases, was used to gather in-depth information (Patton, 2002). In purposeful sampling, a small number of cases are selected to gain knowledge of issues of central importance to the study (Patton, 2002). Rural, poor landowners, a minority population, were chosen from the Sarapiquí area to investigate their experience with PES, particularly given the potentially challenging

circumstances of participation. Cases were selected with the help of employees at FUNDECOR and the area's FONAFIFO office, as they personally know participants and have thorough knowledge of landowner demographics. Twenty-four landowner participants were interviewed, all at, below or just slightly above the poverty line. The first category included fifteen small landowners, with thirty hectares or less enrolled in the program, with 12 out of 15 (80%) living at or below the poverty level. Eight medium landowners were queried, with between thirty-one and seventy-five hectares enrolled, six of whom (75%) reported that they are at or below the poverty level. Six large landowners with seventy-six or more hectares enrolled were also interviewed, with the largest plot being 150 hectares, and 4 out of 6, or 66%, reporting at or below the poverty level. These three classes of participants were chosen to glean a more robust understanding of the various types of landowners and gain more textured insight derived from variations in socioeconomic and landholding status. The majority of respondents

QuickTime™ and a
decompressor
are needed to see this picture.

Figure 4-1: The Study Area Source: costaricamap-online.com

(79%) used other portions of their land not enrolled in the program for, and derived their income from, cattle, pasture, black pepper production and other agriculture. Out of the rest of the participants, one interviewee was a retired hairdresser, another was a part-time

furniture maker, one owned tourist cabañas, one ran a gas station and another ran a butterfly farm on his land. Three non-participants, one from each group (small, medium and large landowners) who reported at or below the poverty line were also interviewed, to gain comparison insight. One staff member each from FUNDECOR and FONAFIFO in the region were also interviewed about PES in general, as well as their specific roles with participants.

Research was undertaken in March 2007. In-depth, semi-structured interviews, lasting from thirty minutes to two hours, were conducted in Spanish, at the participants' home or farm, in order gain familiarity with the land and environment. Components of the sustainable livelihoods approach (SLA) were incorporated in interview questions (Chambers and Conway, 1992). This framework, often used to design projects as well as monitor and evaluation program impacts, is promoted as people-centered, to explore livelihood tactics focusing on financial, social, natural, physical and human assets (Parkinson and Ramírez, 2006). Interview protocols included questions investigating overall thoughts about the program, the aforementioned five assets, ecological literacy, social capital and facilitators and barriers to participation. Non-participants were queried on SLA assets, ecological literacy, social capital and reasons for not participating.

Data analysis was based on a grounded theory approach. Qualitative data was coded to build a frame of key points. From these codes, concepts were formed, and broad groups were then developed to identify results and emergent themes (Glaser, 1998). Theoretical saturation was reached in each category. Glaser defines theoretical saturation as:

- a) no new or relevant data emerges regarding a category
- b) the category is well developed in terms of its properties and dimensions demonstrating variation
- c) the relationships among categories are well established and validated

(Glaser, 1978, pp. 124-126)

Through in-depth discussions incited by the protocols, several emergent themes were identified: perception of participations; program structure; impacts to social capital; institutional support; institutional support; role of government; ecological literacy; role of international community.

4. Results and Discussion

Perceptions of Participation

Almost unanimously, the landowners perceived little benefit from participation aside from environmental protection. All but one participant, or 96% of the respondents, vocalized – usually several times – their discontent with the amount of money received. In fact, it was elucidated that they belong to the program *despite* the monetary compensation they received. “It’s not an adequate amount of money, not for farmers, because other activities get you more [money]. If I go into cattle, I get more. One does this [reforesting] because you like it, and because trees are indispensable.” “In Costa Rica, people have much, even though you say we are poor and that we are peasants, we have a lot because we own the land. We preserve it because it is in our nature, and because we like conservation, despite the amount we receive.”

Transaction costs were frequently specified as a high burden. “They charge their management fee and discount other things as well...so this means that what we get is too low. Definitely!” “I think there should be other alternatives. Like I have heard that there are enterprises that pay for the oxygen [we are supplying] or something like that. Let’s see who pays better for what we are producing.” “Considering the effort of protecting the forest, the amount is not adequate.” Payments generally accounted for less than 10% of landowners’ overall income. All respondents used the money for common household expenses, school fees for their children, and to maintain the land, precluding this money to be invested for long-term savings or sustained quality of life investments. “Basically all we can get from the money is food.”

All participants belong to the program first and foremost because they have a vested interest in conservation for conservation sake. “It is going to be 15 years [that we have been in the program], and we feel...they ask for a lot of requirements and we do not get any benefits. If we leave the program, we will still leave the forest as it is.” “It is not easy to protect the trees, in our case it would be normal for us to make a living from the farm, but we are interested in protecting the forest, we wouldn’t like to cut down the trees. Our interest is in the environment, even if there were not any economical incentives, we would continue protecting the forest, we wouldn’t cut the trees down, we would find other alternatives.”

Respondents explained that even though the money they receive does not compare to other land uses, for the most part they are happy to belong to PES for conservation reasons and intergenerational equity. “I am glad to participate. My children

would say ‘Mom, it’s better for you to get permits to log the trees and have more grass and more cattle.’ But I told them that it’s not needed, since they earn money and they share it with me. So I decided to rather use that land for a better environment, a better future.” “It is important because we need to leave a legacy for future generations.” “It’s likely my grandchildren won’t see the mountains if we don’t preserve them now.”

The small and medium landowners were adamant about the fact that small amounts of land enrolled in PES do not derive adequate financial benefit. Interestingly, even among those interviewees who are classified by FUNDECOR and FONAFIFO as “large landowners” (with 150 hectares being the largest amount in this study), there was a sentiment that this amount was too small to derive benefits from program enrollment. Respondents explained there was too much overhead and competing land uses, particularly pineapple and cattle, could garner much higher return. “Some people told me ‘I am interested in doing this’ but I told them ‘don’t even try, you’ll go broke. I tried with 2 hectares and it didn’t work.’” “You know how [participation] would be good? With 500 hectares, because then you would earn a lot.” “It doesn’t benefit the ‘small ones’ [landowners]. That’s important because you would have to be blind not to say that.” “If a farmer has 5 hectares, he will see that it is very little money that he will receive from the program.” “These current prices only benefit those who have 300 hectares or 100 hectares, but for those of us who have fewer hectares, it is important.” “We think that farmers that have this program as the only source of income should receive more money. In Costa Rica, rich farmers have their farms in these types of programs because it is an easy way to earn some money. For example, if we cut only one

almond tree we would make more money than by being part of this program in a whole year. We think that this is a project for rich people.”

Several expressed an interest in using their forest to attract tourism, but that might be a potential conflict with PES rules, particularly the preservation program. Others articulated a desire to be able to use fallen trees, which is currently prohibited in the conservation and reforestation programs. “It’s not like if I drop [out of the project] I’m going to cut down the forest, no! But I was thinking of leaving FUNDECOR to start a project...I could do some paths to get tourists to come visit my forest, they could walk around, and I could earn some money from that.” “You can’t live off of the income [from PES], so what I need to do is to see how, through [the forest], I can set up another source of income.” “Some are taking advantage of the forest, some people in this area cut down the trees and sell them; I haven’t done that, we have some nice trails and want to bring in tourists.” “If I could do it on my own, having a car or little van coming here and I would get a couple or tourists to come here and visit my farm, and I could take them around to observe birds and give them a tour. That is a good idea!”

Program Structure

Satisfaction about the program structure vacillated. Fifty-eight percent (58%) stated their general content with it. “I have not had any inconveniences. Once the guidelines are clear, there is no problem at all.” However, a large minority (42%) were disappointed with how with the program was run, citing bureaucracy, contradicting information and lack of support as sources of dissatisfaction. “Sometimes they tell us one

thing but the reality is different. It is kind of confusing.” “They have many requirements, too many, in fact. So everything, the projects, had many delays with the payments.” “This last year we were told that by November 14th the checks were going to be ready. I didn’t get mine until January 1st. Because there are many requirements to fulfill!” When asked about how he would change program structure, he replied: “I would almost start over...that there be less bureaucracy, less paperwork, a faster process.”

There was also consensus that more information should be disseminated, and in a contextually appropriate manner. “We need more help, for example, when we enrolled in the program, they told us that we are exempt from taxes, however, some time later we were notified that we owed a lot of money. That needs to be clear from the beginning.” “The contracts were a misery.” “I remember some people from the program talking to us in a very technical manner, and I feel like it should be simpler when you talk to somebody who is on the farm all day.”

Budgetary disapproval was salient. Specifically respondents referenced overcharging for services, budget mismanagement and corruption as problems. “There is a lot of money going for paperwork and intermediaries.” “FUNDECOR [and other agencies] use the money (from participants) to buy brand new cars every year – I believe a car can last more than a year.” “I have told people, look how much a FUNDECOR employee earns per month. It is us who are contributing per year...it is a matter of consciousness! As small as it is, it has to be recognized that we are contributing.” “I do know that other countries donate large amounts for these programs, but I don’t get much. That’s all let to offices, engineers, vice-ministers, minister...and we are last.” “I was

reading about it, and the money that is sent from countries like Holland is much more than the money that we receive. There is a lot of money going for paperwork and intermediaries.”

Impacts to Social Capital

As noted above, previous research points towards positive links with social capital and PES. However, the majority of respondents in the program (54%) said they did not feel supported by their community. “My family is the only support I have.” “The community is not involved.” In fact, many expressed that their participation in PES actually harmed their relationship with neighbors because non-participants tend to look down upon the program, indicating adverse affects on social capital. “The community does not cooperate, they actually do damage by gossiping about me.” “There are many people that don’t agree with the program. They say: ‘you are in that project and we can’t cut down a tree’; they don’t agree.”

These negative perceptions tend to generate an “us vs. them” mentality: “The ones who agree with the program already participate in it.” “We [the participants] know what we are doing, they don’t know what we are doing.” “There are dumb people around here that cut trees down and I don’t think that’s good. We should be planting trees instead.” “People have told me that FUNDECOR hasn’t been good, that they just want to gain money.” “They are not interested, they only care about themselves.”

This sentiment was echoed by non-participants as well. Those respondents indicated that there were better money-generating land uses. “I can make a lot more

money logging or with cattle than with the program.” “If I sign up for those [program] incentives, I limit myself from other opportunities to make money.” They also expressed their concerns about stricter forest policy as a possible result of PES programs.

Regardless of community perception, all participants said they would belong to the program, as 100% said they felt PES was very important. “Because it is my property, and if I understood the information I got about the program, and feel I want to do it because I like conservation, I’ll do it. It is an individual decision.” “I would always participate, it is important to preserve our forests.” “It is important because of the experience and not because of interest for the money.”

On the whole, there is also a lack of communication between those who do participate in the program. Although 50% of PES members do talk with other farmers about the program, 71% of the respondents did not feel this relationship made participation easier, as it was often quite infrequently. “I am all alone, I don’t have any support in this program.” “We had some meetings at the beginning, but now everyone worries about their own properties.” “I don’t really know who else is a part of the program. There is not much chance to know that.” Often the other people talked to in the program were family members, with an already-established relationship.

Key elements of social capital are neighborliness, trust and shared values, and community involvement, among others (National Statistics, 2003). Bridging social capital is described as loose connections between people and is characterized by cross-cutting ties (eg. business associates, acquaintances, friends from different ethnic groups, friends of friends of friends, etc); it is good for ‘getting ahead’ in life (National Statistics,

2003). The above findings suggest there are missed opportunities for bridging social capital to facilitate program participation. In fact, it may actually be weakened between those who do and don't belong to PES.

Institutional Support

Interviewees were mixed about the level of institutional support they received, further demonstrating adverse affects to social capital. Sixty-three percent (63%) of respondents said they did not feel supported by institutions or organizations. "I alone." "There is nobody that comes to you for help." "I don't really feel supported by anyone and I would like more support." "There is nobody that comes to you to offer support." "Up until now, I don't have any support."

Of those who did feel supported by institutions, FUNDECOR and MINAE were the organizations named most often. Help with keeping squatters off the land was cited a main source of institutional involvement. "I feel supported by FUNDECOR because they help to avoid squatters coming into the farm." "I participate in the program mainly to defend my land. Around here all the farmsteads were invaded by squatters. They also spotted my land and the only way to defend yourself here is to join the forestry regime."

Respondents, regardless of whether they felt supported by institutions or not, unanimously indicated that they would like more support from relevant organizations. Above all, participants voiced desire for more educational programs. Attitudes ranged on how often these should be offered, from every three months, to biannually to yearly. A breadth of workshop topics were proffered: identifying tree species; information

particularly geared toward women participants; capacity building and marketing strategies; pollution awareness; water issues; forestry (including first aid in the forest); and building capacity for tourism. See figure 4-2 for a full list of the topics suggested.



Figure 4-2: Suggested Workshops by Participants

Role of Government

Participants were generally satisfied with the job the government is doing with ecosystem management in Costa Rica. Seventy percent (70%) feel that the government plays a collaborative and supportive role. “They are protecting the forest; it's not like before when there was freedom to cut down the trees and plant bananas, now I don't think

that is possible. If that happens [people] can even go to jail.” However, even among those there were suggestions on how this effort could be improved. “It is doing its ability, it should improve though, with more incentives, increasing the education for our schools, for example teaching our children to plant trees.” “They are doing a good job, but should improve it by having more employees to be more efficient.”

On the other hand, 30% of the respondents were dissatisfied with governmental efforts. Corruption was brought up again, as well as lack of involvement and organization as the primary areas of complaint. “I don't think they act accordingly, the farmer is the one responsible for everything and they don't contribute at all.” “I think that we need more participation from it. For example, they are getting more money from gas taxes, that money should be directed to our programs, but now it is money going in their pocket.” “They need to improve their control and perhaps get more money to recruit more people in the program.” “They should do more or we'll starve.” “They are lacking more initiatives, they need to do more to protect the environment.”

Role of International Community

There was unanimous agreement that the international community should bear some accountability for conserving the forest. Participants indicated that because some ecosystem services produce global benefits, protection should be a shared responsible. The majority of respondents (83%) felt that foreign countries were supporting

conservation efforts in Costa Rica, but most added more could be done. “Other countries have money and can invest where environments should still be preserved.” “If all the countries participated [in a similar program], we will have a better environment.” “Other countries don't have what we have [forest], though they would love to have it. With these programs it is possible to preserve the forest a little more.” “Some countries don't have forest but they get benefit as well.” “We must be united and think about the environment, because we are going to need it in the future.” “Because [industrialized] countries are the ones with the biggest problems, they should be paying attention to how the resources are being used. I believe that if it is done here, it can be done anywhere.”

Respondents also pointed out that developed countries more adversely affect the environment and should therefore share the conservation burden. “Because of the forest, there are a lot of valuable things there, a lot of trees, oxygen that is being produced for the world; we are actually contributing to compensate the contamination of other countries.” “Industrialized countries have already polluted a lot of the world.” “Because other countries do not have the environment that we have and they are also contaminating, so they have a responsibility of protecting this.”

Figure 4-3 embodies the relationships and levels of support perceived by landowners participating in PES. Table 4-2 highlights other results.

QuickTime™ and a
decompressor
are needed to see this picture.

Figure 4-3: Level of Support Perceived by Landowners, Arrow solidity demonstrates the level of support: the more solid the arrow, the higher the support

Statement	Agree	Disagree	Illustrative Comment
I receive a fair amount of money for participation.	4%	96%	“This amount is only fair for large landowners.”
Regardless of the amount of money I receive, I would still participate in the program.	88%	12%	“I see that this programs works, it has improved the forest! I wish they would raise the amount of money paid, because I can’t live on this.”
I am interested in renewing in the program.	91%	9%	“This program is interesting, I like to see the country’s debt swapped for nature.”
Other countries are responsible for preserving ecosystem services.	100%	0%	“Everyone has to be responsible.”
This program should be used in other places.	100%	0%	“This program is important and should be done around the world.”

Table 4-2: Participant Responses

Ecological Literacy

All participants demonstrated a sophisticated understanding of forest ecosystems. Although they could not always articulate ecosystem services scientifically, respondents were able to make connections between forests and water provision and regulation, gas regulation (provision of oxygen and carbon sequestration), habitat and refugium, recreation and climate regulation.

Figure 4-4 delineates every service mentioned by a respondent. While some might not technically be considered services (such as fighting pollution) they are included in order to accurately demonstrate the specific language was used. “What we are talking about here is the process of the entire world, what you listen about the water and the role of human beings in its depletion. There is less water every day, and it is being polluted.” “Because of all the animals that live there, if we cut the trees down, they will not survive.” “The environment surrounds us and we need it, because it produces oxygen, water, air purification, trees, flora and fauna.” “I know forests purify air; I know that deforestation is bad, it affects water.” “It is helping us to protect the trees, habitats, springs.” “Forests produce air, water. If in this moment we did not have these trees, it would be fatal. There are also medicinal plants in the forest, and pure water springs. It is also beautiful scenery.” “Forests produce oxygen, protect the soil; they are also the habitat of many species.”

This advanced knowledge was partly gleaned from participation in the program, as well as from personal experience. “What we learned from the program, is that when we take care and protect, [and] tell other people about the importance and the need of that

protection.” “I was always a forest destroyer...this farm was almost 94 hectares and we cut down the rest of the farm. I learned to preserve it, I had a bit of education and currently I want to preserve it as much as I can...and I want to show the community how to use the forest in a sustainable way.” “The purification of the air, at the beginning I didn’t understand the role of the forest in this, but now I do.” “This program showed me how to preserve the ecosystem, the plants and animals of Costa Rica. Before the implementation of this program, we used to cut more trees down, because we used to get some money from that.” Conversely, those that did not belong to the program only listed forest benefits in financial and exploitative terms. “People are not into [the program], there is more money in pineapples.”

These findings reveal that another socioeconomic goal – literacy, particularly ecological literacy – is being boosted through participation. While there may be a correlative effect between higher ecological literacy and participation, the potential for positive impacts on environmental awareness and subsequent behavior change through program participation should be exploited as much as possible.

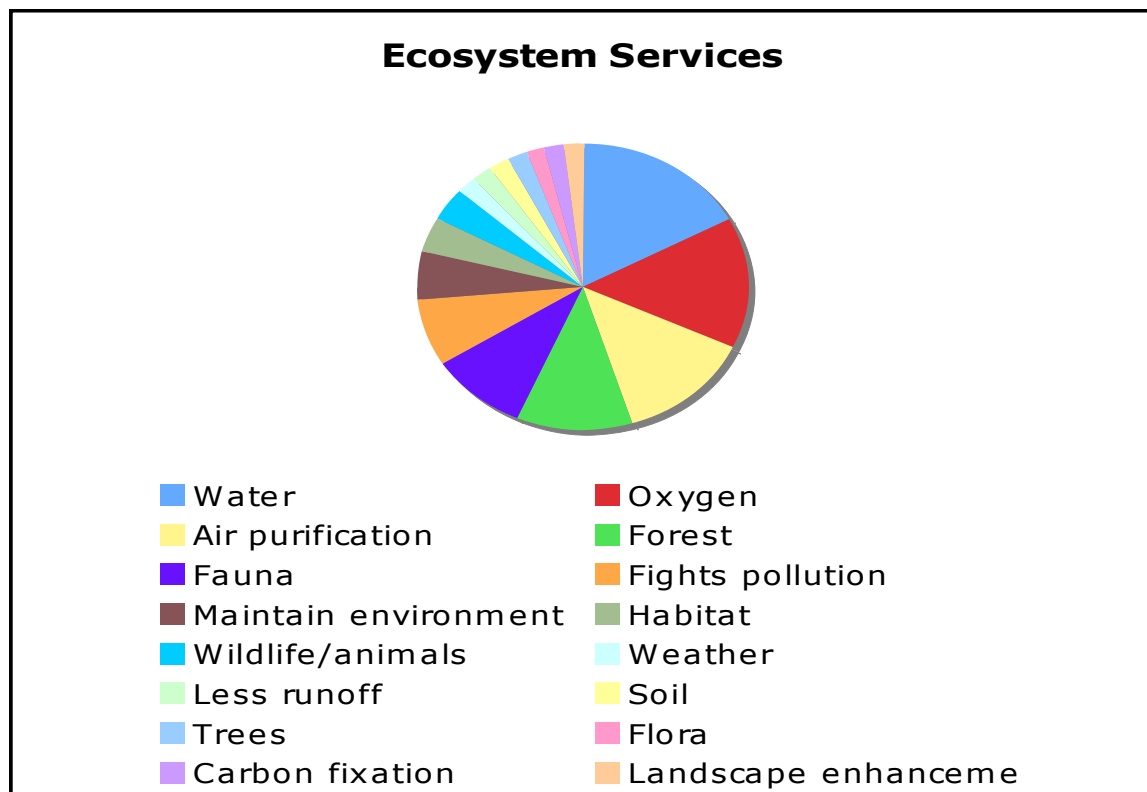


Figure 4-4: Ecosystem Services Mentioned By Name By Respondents

5. Conclusions and Recommendations

Costa Rica's market-based PES is often lauded as an exemplary program. Through in-depth qualitative research, several areas of improvement were identified in order for this and other programs to achieve socioeconomic goals.

To begin, it cannot be assumed that participating in PES makes poor landowners economically better off, as has been indicated in previous research (Pagiola et al., 2005). Results from this study illuminate that participants have non-monetary motivations, such as an intrinsic sense of place, to belong to PES, which may contribute to overall enhanced non-fiscally related QOL. Since these participants may be assuming disproportionately

more burden for conservation, given the fixed transaction fees and low payment comparative to other potential land uses, reducing the burden of transaction fees by eliminating them for the poorest participants or basing them on a sliding scale fee, would work to promote equity in PES schemes. Identifying multiple criteria to measure QOL, incorporating both economic and social factors, will aid in further understanding how QOL is affected by participation.

If PES goals are serious about benefiting small landowners, revisiting the definition of “small landowner” is in order. Research is needed to investigate the realistic amount of land that needs to be enrolled in PES to generate a livable or substantial income, particularly if it is a primary or significant revenue source. Given the low earnings derived from PES payments for those with few hectares enrolled, exploring ways to integrate non-extractive land uses, such as tourism-based activities, could provide further income without breaking program rules. While the importance of detritus and its contributions to overall ecosystem health is recognized, further studies could determine if it is possible to extract small amounts of naturally fallen wood without undue disturbance, enabling complementary land uses.

Taking the time to make program structural adjustments, with the input of participants, could engender social capital and most likely improve program compliance. Often managing organizations most likely have the capacity to modify some aspects of their structure without costly changes. For example, in one area, women in the program approached the organization to request that payments were made directly to them. “There is a saying that men get money and don’t remember their wives. We went

demonstrating to FUNDECOR...and they decided to give the checks directly to women.” Small changes such as these could go far in earning and keeping participant trust.

Participants – even poor participants – in this study appear to have a high level of ecological literacy. Considering there might be initial connection between high ecological literacy and participation, it cannot be assumed that others in their demographic would demonstrate similar awareness. Therefore engaging in targeted outreach and educational programs that specifically work to recruit poorer participants (identified through geographic and demographic characteristics) would go far in widening program access, particularly to those who do not have high levels of ecological literacy.

Additionally, FONAFIFO has recently designated priority areas for new contracts that lie within biological corridors under the GRUAS II report, a territorial ordering that identifies conservation priorities in Costa Rica (Castillo, 2006). While this clearly may benefit conservation goals, it does not necessarily further the objective of poverty alleviation, as their lands may fall outside of the priority areas (personal communication, 2007). Giving preference, through development of specific criteria, to the poorest landowners in the biological corridor, would be one way to target select participants and foster the dual aim of poverty alleviation and ecosystem conservation.

As global carbon and ecosystem services markets grow, foreign countries can continue to amplify their investment in PES similar programs for environmental services. Coupling market-based mechanisms with varied funding initiatives, possibly through direct support to governmental or non-governmental organizations (such as

FUNDECOR), would go a long way in ensuring program viability and possibly increased efficiency.

Foreign countries can supply other means of support as well. For example, all the respondents would be interested in more educational opportunities. While providing workshops would most likely require resources that might not be available by the host country's government or related entities, with the help of international organizations, creative programming, open to all residents, could be offered as means of developing social capital and raising ecological literacy levels. Many participants mentioned the semi-regular presence of foreign organizations in the region, due to their interest and involvement with PES. These entities could work with FUNDECOR and other groups to produce workshops, or entirely take over their planning and execution. Given that many respondents would be satisfied with an annual or twice a year workshop, collaboration or commitment on that scale is entirely reasonable.

Concomitantly achieving conservation and socioeconomic goals such poverty alleviation with a market-based mechanism such as PES is ambitious. While it is impossible that one approach can provide a panacea for conservation and achievement of socioeconomic goals, understanding the nuances of participation as they relate to outcomes is vital for program development. Continued research is critical to identify new areas of synergy and potential for collaboration between interested entities. As one participant pointed out, "Costa Rica is a small country, and we can't hide the sun with one finger, we need to shade it with everybody's help!"

References

- Ayuk, E. T., 1997. Adoption of agroforestry technology: The case of live hedges in the central plateau of Burkina Faso. *Agricultural Systems* 54,189-206.
- Becker, C. 2006. The Human Actor in Ecological Economics: Philosophical Approach and Research Perspectives. *Ecological Economics*. 60, 17-23.
- Beirele, T.C. and Cayford, J. 2002. *Democracy in Practice: Public Participation in Environmental Decisions*. Washington, D.C.: Resources for the Future Press.
- Berentsen, B.M., Hendriksen, A., Heijman, W., van Vlokhoven, H., 2007. Costs and benefits of on-farm nature conservation. *Ecological Economics*, 62, 571-579.
- Brandon, K., Redford, K.H., Sanderson, S.E., 1998. *Parks in Peril. People, Politics and Protected Areas*. Island Press: Washington DC.
- Camacho, S.M.A., Segura Bonilla, O., Reyes Gatjens, V., Miranda Quiros, M., 2002. Gestion local y participacion en torno al pago por servicios ambientales: Estudios de caso en Costa Rica, Centro Internacional de la Politica Economia, CINPE, San Jose, Costa Rica.
- Castillo, E.A., 2006. Proyecto Ecomercdos: Consultoria Para Actualizacion de la Propuesta Technica de Ordenamiento Territorial Con Fines de Conservacion de Biodiversidad en Costa Rica (GRUAS II).
- Chambers, R., Conway, G., 1992. Sustainable rural livelihoods; practical concepts for the 21st century. IDS Discussion Paper 296, Institute of Development Studies, Brighton, England.
- Chichilnisky, G., Heal, G. 1998. Economic returns from the biosphere. *Nature*. 391, 628-629.
- Chomitz, K. M., Brenes, E., Constantino, L., 1999. Financing environmental services: The costa rican experience and its implications. *Science of the Total Environment* 240, 157-169.
- Chomitz, K.M., Fonseca, G.A.B., Alger, K., Stoms, D.M., Honzák, M., Landau, E.C., Thomas, T.S., Thomas, W.W., Davis, F., 2006. Viable reserve networks arise from individual landholder responses to conservation initiatives. *Ecology and Society* 11, 40.
- CIFOR,1999. Your subsidies are my incentives. POLEX. Available at <http://www.cifor.cgiar.org/Publications/Polex/polexdetail.htm?pid=19>, accessed on December 18, 2006.

Costanza, R. 1989. What is Ecological Economics? *Ecological Economics* 1(1), 1-7
Daniels, A., Esposito, V., Bagstad, K., Moulaert, A., Rodriguez, C.M., Segura-Bonilla, O. In Preparation. A decade of PES: Building on Costa Rica's model and applying lessons learned.

Disinger, J.F. and Roth, C.E. 1992. *Environmental Literacy*. ERIC/CSMEE Digest. <http://www.ericse.org/digests/dse92-1.html>, accessed September 2008.

ECLAC (2004). *A decade of social development in Latin America, 1990-1999*. United Nations Economic Commission for Latin America and the Caribbean. Chile, Santiago.

Environmental Education and Training Partnership (EETP). 2004. Environmental Literacy. http://eetap.org/html/environmental_literacy.php, accessed October 2006.

Estado de la Nación, Costa Rica. 2008. Available at: http://www.estadonacion.or.cr/Compendio/soc_pobreza01_06.html, accessed on October 1, 2008.

FONAFIFO, 2006. Environmental Services Statistics. Fondo Nacional de Financiamiento Nacional, San José, Costa Rica. Webpage <http://www.fonafifo.com>, accessed May 2008.

García, R., 1996. Propuesta tecnica de ordenamiento territorial con fines de conservacion de biodiversidad: proyecto GRUAS. Ministerio del Ambiente y Energía (MINAE) and sistema Nacional de Areas de Conservacion (SINAC), Costa Rica.

Glaser, B.G., 1998. *Doing Grounded Theory: Issues and Discussions*. Sociology Press, Mill Valley, CA.

Glaser, B.G., 1978. *Theoretical Sensitivity*. Sociology Press, Mill Valley, CA.

Godoy, R. A., 1992. Determinants of smallholder commercial tree cultivation. *World Development* 20, 713-725.

Grieg-Gran, M., Porras, I., Wunder, S., 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development* 33, 1511-1527.

Hope, R.A., Porras, I.T., Miranda, M. 2005. Can Markets for Environmental Services Contribute to Poverty Reduction? A Livelihoods Analysis from Arenal, Costa Rica. Report under the DFID Forestry Research Programme, Project. No. R8174.

- Krebs, V. (2007). "Social Network Analysis, A Brief Introduction." 2007, from <http://www.orgnet.com/sna.html>.
- Landell-Mills, N. and Porras, I.T., 2002. Silver bullet or fool's gold? A global review of markets for forest environmental services and their impact on the poor. International Institute for Environment and Development, London.
- MacKenzie-Mohr, D. 2000. Promoting sustainable behavior: An introduction to community-based social marketing. *Journal of Social Issues*. 56(3), 543-554.
- McDade, L., Bawa, K.S., Hespenheide, H., Hartshorn, G. (eds.), 1994. *La Selva: Ecology and Natural History of a Neotropical Rain Forest*. University of Chicago Press, Chicago.
- Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.
- Miranda, M., Porras, I.T. and Moreno, M.L., 2003. The Social Impacts of Payments for Environmental Services in Costa Rica: A Quantitative Field Survey and Analysis of the Virilla Watershed. International Institute for Environment and Development, London.
- Morse, J. and Richards, L. *Readme First for a User's Guide to Qualitative Methods*. Thousand Oaks: Sage Publications, 2002.
- National Statistics, UK. 2003. *Social Capital*. Available at: <http://www.statistics.gov.uk/socialcapital/>, accessed on September 10, 2008.
- Neupane, R. P., Sharma, K. R., Thapa, G. B., 2002. Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. *Agricultural Systems* 72, 177-196.
- Ortiz Malavasi, E., Sage Mora, L.F., Borge Cavajal, C., 2003. Impacto del programa de pago de servicios ambientales en Costa Rica como medio de reducción de la pobreza en los medios rurales, Unidad Regional de Asistencia Técnica (RUTA), San José, Costa Rica.
- Pagiola, S., Arcenas, A., Platais, G., 2005a. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. *World Development* 33, 237-253.
- Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ramirez, E., Rosales, M., Ruiz, J. P., 2005b. Paying for biodiversity conservation services - Experience in Colombia, Costa Rica, and Nicaragua. *Mountain Research and Development* 25, 206-211.
- Parkinson, S.a.R., R., 2006. Using a sustainable livelihoods approach to assessing the impact of ICTs in development. *The Journal of Community Informatics*, 2(3).

Patton, M.Q., 2002. *Qualitative Research and Evaluation Methods*. Sage Publications, Thousand Oaks, CA.

Putnam, R.D. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York, New York: Simon & Schuster.

Sanchez-Azofeifa, G., Harriss, R. C., Skole, D. L., 2001. Deforestation in Costa Rica: A quantitative analysis using remote sensing imagery. *Biotropica* 33, 378-384.

Sanchez-Azofeifa, G. A., Daily, G. C., Pfaff, A. S. P., Busch, C., 2003. Integrity and isolation of Costa Rica's national parks and biological reserves: Examining the dynamics of land-cover change. *Biological Conservation* 109, 123-135.

Sayer, J.A., 1995. *Science and International Nature Conservation*. Center for International Forestry Research, Bogor, India.

Segura, O., 1992. Los incentivos forestales en Costa Rica: Politicas economicas del sector, No5. Universidad Nacional, Heredia, Costa Rica.

Sills, E., Hartshorn, G., Ferraro, P., and Spergel, B. 2005. Evaluation of the World Bank-GEF ecomarkets project in Costa Rica. Blue Ribbon Panel Report. North Carolina State University, Durham, North Carolina.

Stake, R.E. 1995. *The Art of Case Study Research*. Thousand Oaks: Sage Publications.

Watson, V., Cervantes, S., Castro, C., Mora, L., Solis, M., Porras, I.T., Cornejo, B., 1998. Making space for better forestry: Costa Rica country study. *Policy that Works for Forests and People Series* No: 6. International Institute for Environment and Development: London.

World Bank, 2006. Scaling up and mainstreaming payment for environmental services in Costa Rica. Project Appraisal. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

Wunder, S., 2005. Payments for environmental services: Some nuts and bolts. CIFOR Occasional Paper No. 42. Center for International Forestry Research, Jakarta, Indonesia.

Zbinden S., and Lee, D.R., 2005. Paying for environmental services: An analysis of participation in Costa Rica's PSA program. *World Development*, 33 (2): 255-272.

Zilberman, D., Lipper, L., McCarthy, N., 2006. Putting payments for environmental services in the context of economic development, The Food and Agriculture Organization.

CHAPTER 5: DEVELOPING A CRITICAL, ECOLOGICALLY CIVICALLY LITERATE (CECL) ECOLOGICAL ECONOMICS GRADUATE: THE USE OF SERVICE-LEARNING IN ECOLOGICAL ECONOMICS EDUCATION

Chapter Summary

Ecological economics focuses on problem-based learning to tackle real-world problems and enhance student understanding of complex issues. A student with firm ecological economic grounding, the Critically, Ecologically Civically Literate (CECL) student, will have integrated knowledge of ecology, socio-economics, politics, civic engagement as well as systems-thinking and critical analysis skills in order to approach comprehensively today's complex problems. Service-learning offers another dimension to problem-based learning to develop such a student: engendering university-community partnerships to meet community needs while providing students with structured opportunities for applied learning. Through service-learning courses, students and communities pool resources and knowledge to work towards sustainable solutions to multifaceted problems. Service-learning, therefore, provides unique methods for students to gain critical-thinking skills and apply ecological economic problem-solving approaches to address environmental, economic and social conditions. This article discusses several case studies of service-learning courses for successful elements and areas needing improvement. Analysis reveals that students become more vested in their work when real-world clients are involved, gain deeper insight to complex problems and systems-thinking and are more likely to make future choices based on their experiences in the service-learning class.

Areas to be addressed include reflection, long-term follow-up and providing extended opportunities to work on the project beyond the tenure of the course to avoid student and/or community feelings of abandonment. The article concludes with discussion and recommendations for successful incorporation of service-learning into ecological economics curricula.

1. Introduction

“If one listens carefully, it may even be possible to hear the Creation groan every year in late May when another batch of smart, degree-holding, but ecologically illiterate, *Homo sapiens* who are eager to succeed are launched into the biosphere” (Orr, 1994; p. 6).

Although David Orr (1994) wrote this more than a decade ago, it still holds true for the majority of today’s college graduates. As an emerging field, ecological economics (EE), a transdiscipline that focuses on problem-based learning to tackle real-world problems, is in a unique position to cultivate well-rounded graduates and thus launch competent decision-makers into the biosphere. A student with firm ecological economic grounding, the Critically, Ecologically Civically Literate (CECL) student, will have integrated knowledge of ecology, socio-economics, politics, civic engagement as well as systems-thinking and critical analysis skills in order to approach comprehensively today’s complex problems. However, this sophisticated skill set is not always best developed in a static classroom environment. Often, in order to cultivate true understanding of messy problems, student must be exposed to realistic examples.

This paper first presents a theoretical basis for the essential components of a CECL student. A discussion of case studies of several service-learning classes and analysis of student experiences follows. It concludes with recommendations on how to integrate service-learning into EE courses.

2. Foundational Concepts

Ecological Economics as a Transdiscipline

“Ecological economics exists because a hundred years of disciplinary specialization in scientific inquiry has left us unable to understand or to manage interactions between the human and environmental components of our world. In an interconnected evolving world, reductionist science has pushed out the envelope of knowledge in many different directions, but it has left us bereft of ideas as to how to formulate and solve problems that stem from the interactions between humans and the natural world.” (ISEE, 2008).

The International Society for Ecological Economics (EE) has clearly laid out the basis for the evolution of EE. As problems become more complex (or they are being recognized as more complex), the need to apply multiple perspectives to work toward comprehensive solutions becomes paramount. The more that is understood about systems behavior, the more it is recognized that it is not based on binary or linear logic in the Aristotelian tradition (Max-Neef, 2005). The University, whose methodological approaches are often based on this tradition with its rigid disciplines, therefore finds itself

in a crossroads of advancement. To continue to promote a reductionist approach to science, education and research, narrowly defining fields and disciplines, will not generate the competency necessary for multifaceted problem-solving. Yet current bureaucratic barriers often restrict flexibility with publishing, review, promotion and tenure, which tends to uphold and reinforce disciplinary boundaries (Costanza, 1990; Hammer and Soderqvist, 2001; Max-Neef, 2005).

Despite institutional lethargy, transcending disciplinary boundaries for synthesized work has been gradually increasing in higher learning (Pickett et al., 1999; Turner and Carpenter, 1999). In fact, varying levels of collaboration garner distinct terms. In a *multidisciplinary* approach, researchers with distinct disciplinary theories, skills and data all address a common problem to produce separate analyses that offer various perspectives without integration (Golde and Gallagher, 1999; Max-Neef, 2005). In *interdisciplinary* research, people and perspectives from various fields work together to structure a problem, design a methodological approach, and examine the data for an integrative analysis (Golde and Gallagher, 1999).

The term *transdisciplinarity* was first introduced by Jean Piaget in 1970 and has been more elusive to define because various schools of thought have applied different meaning to it (Nicolescu, 2002b). The concept most aligned with EE is that offered by Nicolescu (2002a): a principle of going beyond disciplines with the goal of “understanding the present world, of which one of the imperatives is the unity of knowledge” (p. 44). By transcending disciplines, transdisciplinarity “concerns the dynamics engendered by the action of several levels of Reality at once” (Nicolescu, 2005,

p. 2). These realities include “values and correspondence between the external (object) and internal (subject) worlds” (Nicolescu, 2005, p. 2). In fact, transdisciplinarity is based on three essential pillars: “multiple levels of Reality; the logic of the included middle; and complexity” (Nicolescu, 1997, p.2). These pillars determine the methodology needed for the research being conducted. Thus, transdisciplinarity is applied for real-world relevance and appropriateness:

Transdisciplinarity is globally open. Transdisciplinarity entails both a new vision and a lived experience. It is a way of self-transformation oriented towards knowledge of the self, the unity of knowledge, and the creation of a new art of living in the society. Nicolescu, 1997, p. 3.

In this way, transdisciplinary research anchors itself in the real world, incorporating values, ethics and philosophy - all of which are purported to be removed from scientific inquiry - to solve existing problems (Max-Neef, 2005). Max-Neef discusses the inherent hierarchical levels involved in transdisciplinarity, with the bottom of the pyramid consisting of the empirical level, demonstrating what exists. This level includes specified disciplines, such as mathematics, geology and sociology. The next level, the purposive or pragmatic level, including architecture, engineering and agriculture, illuminates what we are capable of doing. The normative level consists of fields such as planning, law and design, demonstrating what we want to do. Finally, the highest level, the value level, integrates all of the levels in a way that determines how to do what we want to do. (Max-Neef, 2005). Transdisciplinarity, therefore, takes research

and education out of the realm of traditional university disciplines and into a space that inherently includes a plurality of approaches, perspectives and acknowledges that values, philosophy and ethics must play a role in complex problem-solving. The inherent transdisciplinary nature of ecological economics goes far in exposing students to this necessary multi-pronged and multi-level approach.

Critical Literacy

Critical literacy has been defined in myriad ways by educators and theorists. As a pedagogical approach, critical literacy emerged from the teachings and writings of Brazilian educator Paulo Freire, who advocated that developing literacy in oppressed populations should be used to not only instruct reading and writing, but it can also be used to allow these peoples to become aware of and challenge unequal power relations, as often seen between governments and corporations and the working poor (Anderson and Irvine, 1993). By analyzing text, media and other informational sources through a critical lens, people can become conscious of their experience as it fits in a historical context that includes uneven power structures (Anderson and Irvine, 1993; Freire, 1970; Lankshear and McLaren, 1993). Freire (1970) argues that through the critical literacy process, people cease to become “subjects” (those who know and act) and “objects” (those that are acted upon), but transform into creative, dynamic beings who actively participate in the invention and re-invention of knowledge.

Since the almost four decades of Freire’s writings on critical literacy, the approach became very popular in English-speaking cultures and has been widely adopted

in schools throughout the United States, Australia, Canada and New Zealand (Luke and Freebody, 1997; Vasquez, 2000). Lewison et al. (2002) identify the four dimensions of critical literacy that have emerged from the literature:

- 1) disrupting the commonplace
- 2) interrogating multiple viewpoints
- 3) focusing on sociopolitical issues
- 4) taking action and promoting social justice (p.382)

Bowers (2001a) and Furman and Guenewald (2004) discuss the need to examine another, fundamental layer of critical literacy. Even though critical literacy stresses the importance of fostering social justice dialogue, often there is a disconnect between those implications and the Western philosophical foundation upon which existing systems are based, such as the individualistic nature of capitalism and the lack of recognition of limits to economic growth due to planetary capacity (which was even absent in Freire's work).

“A problem seldom acknowledged in educational approaches to social justice is that they tend to reinforce, rather than question the Western Enlightenment assumptions that underlie existing social and cultural systems, as well as related educational assumptions about the legitimacy of practices that lead to cultural reproduction...Further, from an ecological perspective, most discourses on social justice are incomplete because they are concerned exclusively with human beings and fail to acknowledge the interdependence of social and ecological systems. This anthropocentric orientation further reinforces assumptions about the

legitimacy of existing cultural patterns (e.g. economic expansion and hyperconsumerism) and lacks the conceptual vision to acknowledge ecological problems or to see the social justice problems humans created for themselves when they damage their nonhuman environments.”

(Furman and Gruenewald, 2004, p. 52-53)

This updated version of critical literacy, therefore supplies another dimension, from which ecological economics can work to challenge students to question, among other things, the dominating neo-classical economic paradigm. Through the use of critical literacy, students are encouraged to become discerning consumers of the information they receive. While critical literacy should be the frame from which all teachers work to address social justice issues such as racism, classism, environmentalism and economic development in primary and secondary school curricula, the growing pressure of measuring school achievement through mandated testing denigrate the ability for educators to creatively weave it into the classroom (Bowers, 2001b; Furman and Gruenewald, 2004). It is thus quite relevant to continue with this framework when working with students in higher education as well.

In an ever-increasing globalized world, international service-learning can provide a unique lens for students to analyze worldwide development and other trends. Differing from traditional study abroad programs, students in an international service-learning class can work with and learn from local communities in a professional and systematic manner. Working in cross-cultural settings, particularly in developing countries, exposes students to issues related to economic and cultural hegemony. Without proper reflection and

discussion, however, Keith (2005) cautions that unequal power dynamics can be created and stresses that interdependence, not reciprocity, is a true product of mutually-beneficial international service-learning. Students faced with poverty, subjugation and other situations of inequality can tend to feel they are lucky and privileged in comparison. However, Keith argues, that once students (and faculty) recognize the flip side to privilege is oppression, and that “through others and in relationship with them...we come to know and fulfill a more complete sense of ourselves and the world” (p.16). Hence, service-learning can create a true sense of interdependence, not only with other humans, but all living species, highlighting human interdependence with ecosystems and the planet.

Civic Literacy

Critical literacy provides a fundamental lens from which to view the world. An application of critical literacy, civic literacy – the knowledge and capacity of citizens to make sense of their political world (Milner, 2002) – is necessary to both question existing political structures as well as become active and engaged citizens. Aspects of civic literacy include: “participating effectively in civic life though knowing how to stay informed and understanding governmental processes; exercising the rights and obligations of citizenship at local, state, national and global levels; and understanding the local and global implications of civic decisions” (Partnership for 21st Century Skills, 2004). While critical literacy provides students with the analysis skills to be savvy consumers of information, or *how* to look at the world, civic literacy provokes students to

take their knowledge to become engaged citizens, or *what* to do in the world. A major tenet of civic literacy is that collective action (such as voting and community improvement activities) is an essential step in changing cycles and systems (Kirlin, 2002; Milner, 2002). This emphasis on collectiveness supplies an important counter to the underlying capitalist paradigm that emphasizes the *I*, or the individual. Hence civic literacy not only promotes questioning existing structures, but also stresses the significance of active participation for social change.

The decline in civic participation and its consequences has been discussed at length in educational, political, sociological and other literatures (Milner, 2002; National Commission on Civic Renewal, 1998; Putnam, 2000). Putnam (2000) and others (see Campbell, 2000; and Delli Carpini and Keeter, 2000) have examined the connection between weakening civil engagement and degrading social capital, which can lead to a decrease in social networks, increased isolation among groups, augmented crime rates, and even disenfranchisement. Milner (2002) offers a comparative analysis of Western democracies to demonstrate the importance of institutional arrangements and policies in shaping civic literacy and participation. In Scandanvian countries, for example, higher public spending on adult education leads to elevated voting and civil participation rates. The lack of educational emphasis and differing institutional relationships in English-speaking countries, however, leads to disproportional participation in civic life connected to socioeconomic status (the higher the status, the higher the participation). This lack of civil participation has been tied to, among other things, waning emphasis in schools (Bowers, 2001a; Milner, 2002; Niemi, and Junn, 1999).

Higher education should play a vital role in developing a civically literate populace. In fact, one of the original main missions of the American research university was to develop knowledge to perform service for the nation (Anderson, 1993; Harkvay, 2000; Kennedy, 1997; Keohane, 1993). This was a uniquely American addition to the educational approach taken from traditional university models from Germany - which was almost entirely research based - and England, which placed an emphasis on teaching (Keohane, 1993). However, this mission has morphed through time, due to factors including creating more narrowly defined disciplines and departments, professionalizing research and the influence of the Cold War and national security (Checkoway, 2001; Lucas, 1994). Rice (1996) investigates this impact on faculty, asserting that their role changed “from service to science”, leading them away from more applied research intended to serve society to investigating questions that generate knowledge for knowledge’s sake. This shift emphasized research and methodologies based in scientific neutrality and a focus on departments in lieu of communities (Checkoway, 2001; Rice, 1996). In recognizing the vital role that educational institutions must play in developing civic literacy, Checkoway (2001) calls for a renewal of the civic mission of the American research university to provide education for citizenship.

Understanding and participating in the political process also holds major implications for promoting sound ecological practices. For example, Gross Domestic Product (GDP), the measure of outputs and services produced by labor and property in a current, is one of the most important measures of a country’s well-being. Much research has illuminated the shortcomings of using GDP as an all-encompassing metric,

(Costanza, Daly, 1996; England, 1998; Lintoot, 1995) including reasons such as things like oil spills are a boon GDP but obviously detract from overall well-being. In fact, emerging ecological economics research is focusing on the need to restructure property and other laws to recognize environmental limits to growth (Guth, 2008; Spence, 2001; Tomer and Sadler, 2007). Engaged, politically-savvy citizens are needed to be able to advocate for sound policies and laws that promote sustainable well-being within ecological limitations.

These two frameworks – critical and civic literacy – inform the development of ecological literacy.

Ecological Literacy

The concept of ecological literacy is still in its nascent stages. While there is not one standard explanation that allows uniform understanding of it, there have been attempts at laying a common framework for comprehension. Considered to be among the founding fathers of ecological literacy, Disinger and Roth offer a widely accepted definition: “[the] capacity to perceive and interpret the relative health of environmental systems and to take appropriate action to maintain, restore, or improve the health of those systems...defined in terms of observable behaviors...knowledge of key concepts, skills acquired, disposition towards the issues...” (Disinger and Roth, 1992, p.3).

This definition outlines a complex relationship between environmental understanding and behavior. In fact, to further explicate this multifaceted relationship, the National

Project for Excellence in Environmental Education delineates four elements of ecological literacy:

- 1) knowledge of environmental processes and systems
- 2) skills for understanding and addressing environmental issues
- 3) questioning and analysis skills
- 4) personal and civic responsibility (EETAP, 2004).

The last two elements encompass critical and civic literacy.

An essential component of ecological literacy is the capacity for systems thinking, defined as “a mindset for understanding how things work...it is a perspective for going beyond events, to looking for patterns of behavior, to seeking underlying systemic interrelationships which are responsible for the patterns of behavior and events” (Bellinger, 2004). Although the concept of systems thinking derives its roots from many of the great thinkers such as Descartes and Newton, it has gained increased attention in the past several decades (Jackson, 1991). Systems thinking recognizes that cause and effect are not close in time and space. Current paradigmatic thinking, however, most often does not acknowledge this time lag, causing a “fundamental mismatch between the nature of reality in complex systems and our predominant ways of thinking about that reality” (Senge, 1990). The development of horizontal thinking, or understanding of linkages across systems, requires a shift of perspective as well as educational foci (Richmond, 2005).

The need for transdisciplinarity, and its components of critical, civic and ecological literacy are paramount. However, as discussed above, discipline, departmental and other constraints of the existing higher educational structure do not easily facilitate the development of such a student. Integration of accessible yet innovative teaching strategies, while working to change the educational system in the long-term, provide short- and medium-term options for cultivation of the CECL student. Service-learning supplies such a strategy, while providing students and faculty the opportunity to solve real-world problems.

Service-learning

Service-learning is defined as “a form of experiential education in which students engage in activities that address human and community needs together with structured opportunities intentionally designed to promote student learning and development,” with reflection and reciprocity as key concepts (Jacoby et al., 1996, pp. 5). Through service-learning courses, students and communities pool resources and knowledge to work towards sustainable solutions to multifaceted problem. Reflection, or intentionally thinking about the experience, distinguishes service-learning from other types of courses (Honnet and Poulsen, 1989; Jacoby, 1996; Weisskirch, 2003). Since service-learning classes are inherently experiential, students may be exposed to people, situations and complex issues that they have not encountered before, with powerful results. Reflection, through journal entries, guided writing pieces, oral discussions, electronic means (ie. class home pages, chat rooms and on-line surveys), presentations and commenting on

directed readings, enables students to process critically and connect the service experience to course content (Cushman, 2002; Eyler and Giles, 2001). Reciprocity between the faculty and students and community partner is another essential element of service-learning. In traditional community service, there is often a one-way approach to service: people with more means and competency are helping those with less means and competency. In contrast, the service-learning relationship between community partners and university members is equal, with each partner bringing skills, experience and knowledge to the relationship, creating “a sense of mutual responsibility and respect between individuals in the service-learning exchange,” (Kendall, 1990, p.22). Service-learning, therefore, provides unique methods for students to gain critical-thinking skills and apply ecological economic problem-solving approaches to address environmental, economic and social conditions.

Service-learning has enjoyed a long history in the university setting, beginning in the 19th century and blossoming under the work of John Dewey and William James, who laid its intellectual foundations in the early 20th century (Jacoby and Associates, 1996; Titlebaum et al., 2004). Through programs such as the Civilian Conservation Corps (CCC), the Peace Corps, and Volunteers In Service To America (VISTA), civic learning through service enjoyed a resurgence in the 1960s through the present (Harkvay, 2000; Jacoby, 1996). Today the broad calls for renewing the civic mission of the university have augmented service-learning programs and opportunities available. An increasing number of colleges and universities are forming or strengthening service-learning programs to work with faculty and staff to establish and maintain partnerships with

community groups, both nationally and internationally (Jacoby 1996). Service-learning projects can range from one-time collaborations, such as a class working on a special exhibit for an educational display, to on-going efforts, such as working with a community on long-term development projects.

Preliminary research has demonstrated that student outcomes improve with service-learning. In a comprehensive evaluation Astin et al. (2000) identify eleven outcome measures for undergraduates and find that service-learning was beneficial for all measures (G.P.A., writing skills, critical thinking skills, self-efficacy, leadership activities, self-rated leadership ability, interpersonal skills, choice of a service career, plans to participate in service after college, commitment to activism and promoting racial understanding). Astin and Sax (1998) found that 12 civic responsibility outcomes were positively correlated with service-learning participation. Working for a non-profit, increased commitment to helping others, serving community, promoting racial understanding and doing volunteer work were among those civic outcomes. Eyler (2000) has linked service-learning to increased civic engagement and social responsibility as well. Kraft (1996) demonstrates how service-learning has been historically used to reduce prejudice and increase self-worth and self-esteem, insight and open-mindedness. Koliba (2003) found that service-learning is an effective way to increase social capital to positively influence student performance. These findings have been corroborated by other studies (see Driscoll, et al., 1998; Eyler and Guiles, 2001; Honeycutt, 2002).

Service-learning holds much potential for enhancing ecological literacy and systems thinking as well. By its inherently applied nature, service-learning can enhance

students' understanding of messy environmental problems and understand their complex nature. Although not much research has been done on environmental service-learning (Madigan, 2000), Lieberman and Hoody (1998) find that high school students in schools that used the environment as an integrating context for learning consistently performed better than their peers in traditional programs on eight key areas: general educational benefits, thinking skills, comprehensive assessment, language arts, math, science social studies, improved student behavior and improved attendance and attitudes. Given the promise of service-learning, further research is merited to determine if it is an effective pedagogical approach for ecological economics to develop a CECL student.

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are needed to see this picture.

Figure 5-1: The CECL Student

3. Methods and Cases

Data was collected from four service-learning courses that were offered by the University of Vermont between 2005-2007 for which the author served as a teaching assistant. A methodological triangulation, based on grounded theory approach, was

employed to gather robust data. Throughout the courses the author took detailed notes and observations during class time; personal conversations on an informal basis with many of the students allowed for deeper understanding of student perceptions and views, and how they evolved over the semester. The author also conducted reflection exercises throughout the courses, taking detailed notes, and written reflection materials were analyzed. Surveys were administered to students to further assess emergent themes. In grounded theory, qualitative data is first coded to allow the key points to be gathered. These codes are then grouped into concepts. Next, broad groups are generated to establish results and identify emergent themes (Glaser, 1998). This primarily qualitative approach allowed for in-depth scrutiny and understanding of the nuances of the student experience that are not easily distinguished through quantitative measures.

By leading reflection discussions, as well as document analysis of more than 400 journal entries and written reflection work, the author was able to gain greater in-depth insight into individual experiences, track student growth and ascertain student understanding of complex issues and their abilities to link service to abstract course material throughout the semester. Journal entry topics varied, as some were assigned (“How does what the author talks about in the article relate to your service experience?”) and some were open, in which the students could comment on any aspect of their experience.

Finally, surveys were distributed six months after all courses were completed to discern and evaluate important emergent themes in student experiences. Twenty-one out of fifty-two total students (40%) answered the survey, with questions intended to evaluate

overall course experience; connection to service partner and civic engagement; contribution to systems thinking/critical literacy; ecological literacy; lasting impact of course; civic literacy and student attitudes about service-learning.

The first course took place in the fall of 2005 and examined community empowerment through grassroots organization by employing a soccer-based curriculum to teach youth about HIV/AIDS prevention on a batey in the Dominican Republic. Bateys are settlements of both Dominican citizens and Haitian migrant laborers originally set up as work camps by the Dominican government in the 1940s. Batey communities are usually isolated, impoverished and lack access to basic needs and human rights. The course consisted of a 10-day visit to the batey, with three class meetings before and a final presentation to the university community after the trip. Twelve undergraduate students registered and completed the course, who were trained to administer the HIV/AIDS curriculum to local youth leaders who would conduct it in their communities to facilitate peer education. Students also assisted on community projects, such as construction of a school and setting up a computer center with donated equipment. Reflections consisted of nightly oral sessions, two journal entries during the trip as well as a final written reflection upon returning home.

The second course, with fifteen graduate students and one undergraduate, was taught in the Fall of 2005 and was a participatory systems-modeling course that worked with three communities in the Northern Forest in Vermont, New Hampshire and New York to develop eco-tourism strategies. The semester-long course conducted three participatory workshops with community members to build dynamic computer models,

using variables and parameters identified by the participants. Student teams further developed the models from the sessions over the semester. The final products were then presented to the communities to be used and maintained to make future decisions. Students were required to hand in weekly journal entries and a final written reflection piece. Two oral reflection sessions were also held during the semester, one mid-semester and one at the end, to facilitate discussion about the service experience.

The third course, conducted in the Spring of 2005, examined the economic, ecological and social impacts of a natural gas pipeline in Camisea, Peru, on indigenous communities. Students in this semester-long course had interactive sessions with speakers, conducted an ecological economic evaluation, performed an in-depth conflict analysis and developed a documentary script about the issue. Results were shared with civil society groups that advocate for the affected indigenous communities and are working to develop more comprehensive guidelines for the next phase of the pipeline project. Seven graduate students enrolled in and completed the course. Weekly journal entries prompted student reflection throughout the course, as well as weekly reflections during class time.

The fourth course, held in the Spring of 2007, was a semester-long course of 17 undergraduate and graduate students that included a 10-day atelier held in Costa Rica. Ateliers are problem-solving, skill-sharing workshops conducted in local communities that include guest lectures, applied interdisciplinary case studies and student design work on a specific local issue. This course examined the country's pioneering Payments for Ecosystem Services (PES) program, and student groups worked with practitioners to

develop successful applications of such programs in Brazil, the Caribbean, the U.S. Pacific Northwest and other locations. Classes before the trip introduced relevant theory, while the final products of the class were white papers to interested communities about how to implement PES programs in their locations. Written reflections consisted of weekly journal entries as well as a final reflection piece; oral reflections occurred daily while in Costa Rica.

4. Results

Several salient themes emerged from the service-learning experiences: increased comprehension of community issues and civic responsibility; developing critical literacy; the level of involvement the students had with the communities; the level of investment the faculty had with the community; effects on future choices; and complex problems and ecological literacy.

Increased Comprehension of Community Issues and Civic Responsibility

Students' civic responsibility and understanding of community issues were heightened by their service experiences. An overwhelming majority of the students continued with their involvement with the problem introduced in the course after the semester ended, either through continued service work or taking more classes pertaining to the subject. Fifty-five percent of those surveyed responded said that through the class, they were more aware of community issues and seventy-nine percent feel that they were exposed to community issues that they would not have been exposed to in the classroom.

These sentiments were echoed in journal and class reflections. As one student expressed, “what we learned could never be conveyed through the classroom; it could never be conveyed through words.” This sentiment was often repeated: “the learning in this course is truly valuable because it involved a very unique situation that is impossible to created...this learning is the type of learning that promotes peace and solidarity.” “Firsthand information and learning by doing is a much smarter way of learning something because it forces you to understand the environment you are living in and there is no substitute.”

Particular to the international courses, students struggled with what it means to be a United States citizen or resident in an increasingly globalized world. “I don’t like how I am a representative of a country involved in a war I don’t believe in...and I don’t like how I am a citizen of a country who has somewhat ostracized itself from the rest of the world and then acted like it was something that had to happen.” The experiences also engendered connections to be made about civic responsibility: “I will use my power as a U.S. Citizen to vote for candidates who I feel will best represent my interests and the interests of impoverished communities abroad.”

Critical literacy

Through strategic readings and subsequent oral and written reflections, students were challenged to examine their role in the community and the existence of unequal power relations. For example, one class was assigned Illich’s “To Hell With Good Intentions,” in which he entreats Peace Corps volunteers in Mexico to go home,

explaining that “the existence of organizations like yours is offensive to Mexico,” (p.1). In the oral reflection that followed, some students were moved to tears as they confronted, possibly for the first time, (and arguably the most powerful) issues of privilege, power and hegemony.

As a result of their readings and experiences, students were able to distinguish the difference between reciprocity and interdependence. “Our diversity we used as a strength, helping us see each new issue from another’s perspective.” “People of [the community] knew that I was a person, not just a number, and more importantly I hope they understand that I knew and respected this about them as well.” They were also able to put their experiences in the broader context of course content: “they are using their cultural role as bearers of community cohesion...like much of my experience [here], this was a double-edged sword...this is a function of my culture and society contrasting with theirs. Which is wonderful.” “I am not convinced that ‘community involvement’ is the answer for ‘managing conflicts and power disparities in planning’ as the authors claim.”

Level of involvement

The amount of contact with partners and direct interaction with the community varied, sometimes widely, across the four courses. Although students recognize that working with communities usually demands more time, the students whose courses did not have a high level of community interaction felt that detracted from their overall experience. While they were producing a tool to be used by the community, they struggled with the fact that it wasn’t created in a truly collaborative environment. “I

would actually prefer more contact with the community”; “this class has allowed me to see difficulties in the process of approaching communities as an outsider and doing meaningful work with them.” Students also acknowledged that there are challenges for communities to align their schedules with an academic one, but recognized that effort as essential. In fact, frustration was experienced by those students who did not have ample community time, while no one expressed a problem with the class taking up too much time in those courses where there was high level of interaction with the communities. Among those surveyed, 100% of the students in a course with a high level of interaction with the partner agreed that they felt they were positively contributing to the community, while only 16% of those students in a course with less direct involvement agreed.

Level of investment

While sixty-one percent of surveyed students affirmed that they were more invested in their coursework because they knew there was a real-world partner involved, the level of investment with the community is significant. As the saying goes, relationships matter, particularly long-term relationships. Students who took part in a course in which the community and faculty member had a history and established long-term relationship derived more from the experience than in those courses with short-term associations. This became clear through the surveys, observations and discussions with students. Through long-term relationships, both the community organization and the faculty member can gain a deeper understanding of their own skills, strengths and need as well as those of their partner. This knowledge can facilitate a more level partnership,

built out of mutual trust and respect, which will influence how student view their roles as well. “I kept trying to put myself in the shoes of the members of the community where a historically privileged group of people had come to my community to tell me how to better live...it felt terribly demeaning. Then I realized that I was really there to learn, not to teach to an audience I did not know.” Relationships that are built with long-term partners, over the course of several semesters with on-going work, engender reciprocity and enable interdependence to develop over time (Keith 2005). Students are aware of depth of the relationship, which can affect their views of the usefulness of their work. “It struck me that the models we are dealing with have a very short lifespan.” “What I find problematic...is that we are trying to push what we have so far and make a premature evaluation of a process that is at a very early stage.”

Direct interaction with a community, especially in an environment that is very different than the one the student is coming from, can be quite intense. Often strong bonds are established quickly; when the semester ends, students might feel a lack of closure or the need to continue work within the community. Psychologically, just knowing it is possible to continue working with the community, through an established long-term relationship, can provide comfort and even affect future decisions. “Knowing that I have the capacity to love someone I barely know and want to be a community I’ve been with for a few days is something that shakes me. Knowing that I have the means and opportunity to fulfill these capacities is the beginning of an involvement that will continue to flourish. I will return...and I will start to factor this community into my mental deliberations.”

Future decisions

Service-learning also contributed to students' future decision-making. Of those surveyed, half of the students (50%) said that the service experience influenced other decisions they made in their life, particularly about their careers. Sixty-two percent said they will enroll or have taken more service-learning classes as a result of the class (some did not have the option due to graduating or program requirements). Several students talked about changing their focus of study, continuing with the project for thesis work or getting a job in the field because of the service experience. "As an environmental studies major, I now plan on focusing my concentration on international community development, particularly in Latin America." "I hope to eventually live and work in a Latin American country in order to help communities live more sustainably and gain better rights and access to health care and education from the government." Seventy-five percent of surveyed students said they have continued their work with the problem introduced in the course.

Complex problems, systems thinking and ecological literacy

Recalling the aforementioned four key elements of ecological literacy, developing understanding of complex problems and systems thinking are integral parts. Since service-learning deals with real community partners with multi-faceted issues, students are undeniably exposed to complexity. It was evident, through conversations, examination of class work and journal reflections, that students gained a more profound understanding of multifarious issues. Eighty-six percent of those surveyed said the class

contributed to their understanding of complex problems. “It’s hard to get a good idea of how theoretical systems work without seeing them directly applied.”

This also led to an enhanced comprehension of systems-thinking. “It becomes more obvious everyday that Natural Resources management, whether by professionals in the field, or by local governments, need to focus on the whole systems, not just part of the system.” “I think this class has helped me to think about the whole systems in mind. It has also helped me to consider how people feel about the different aspects of systems, and how these must be considered carefully when attempting to make decisions that will affect the public.” “I have developed a deeper appreciation for the interdisciplinary nature of life and the importance of incorporating this reality in education.” Students learned the intrinsically complex nature of most problems that requires an applied and thorough method to solve them. “I will take a consistently more pragmatic approach to problem solving.” “This class has made me think and wonder and analyze and struggle with more issues than any other class. ” More than half of those surveyed (52%) felt they had a positive impact on an environmental problem.

Figure 5-2 demonstrates several other relevant findings.

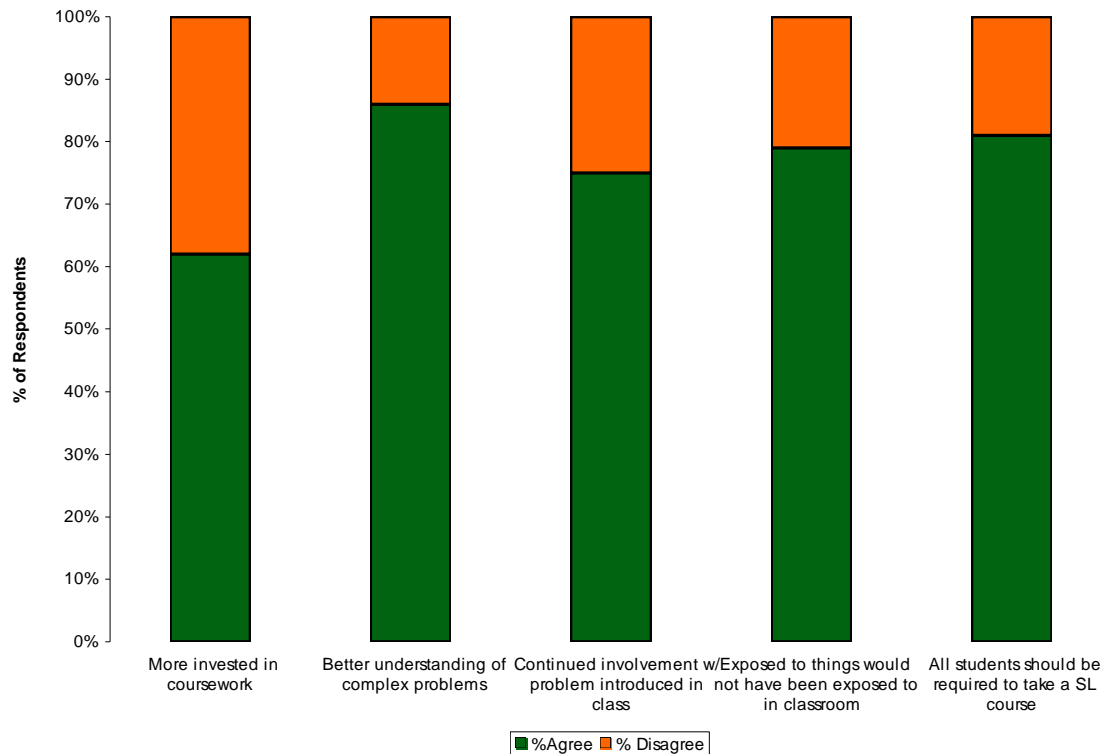


Figure 5-2: Selected Findings

5. Conclusions and Recommendations

The service-learning courses that were studied clearly contributed to students' critical, ecological and civic literacy in a way that most likely would not have been attained in the classroom. Comprehension of complex problems and systems thinking were enhanced through applied problem solving with community partners, positively contributing to development of the CECL EE student. Exposure to unequal power dynamics and other situations provoked students to more deeply analyze concepts such as globalization; problems with participation in environmental planning; and unsound environmental policy formation. Issues such as inequitable health care systems,

indigenous rights regarding natural resources and the ethics of technology and its use in environmental planning were dissected and assessed. Students both articulated and demonstrated in observable ways their growth and deeper understanding of these issues than if they had not participated in the service component.

While all four of the courses studied contributed to this learning, there was considerable variation across experiences, correspondent with the level of interaction with the community. These class experiences illuminated that the deeper the relationship is with the community partner and the more time spent with each other, the greater the benefit. Service-learning entails significant commitment - of time, resources and energy - to be successful. The community must be willing to invest time and other resources in this partnership, and all parties must be aware that these relationships develop over time. Consistency and reliability are two essential components to a mutually beneficial relationship, requiring students and faculty to reshape their notions of traditional course demands. This can often be challenging when thinking about the tenure structure in which service is not rewarded as much as publications, grants and other professional achievements.

Long-term relationships are significant, yet it is not always possible to develop semester-long courses. A variety of formats of service-learning classes, such as short-courses and ateliers, skill-sharing workshops, can be explored. Being creative and tailoring the service experience to the particular problem is essential to meet the needs of both the class and the community partner. Offices or staff members dedicated to facilitating service-learning opportunities are growing in numbers across campuses and

serve as excellent resources for faculty and community members interested in forming relationships. Service-learning programs can also complement other efforts in the growing push for sustainability on campuses.

Given the messy nature of environmental problems, it is clear that the traditional classroom setting is not sufficiently equipping students with the skills and knowledge needed to begin solving them. As a transdiscipline, ecological economics is in a unique position to advocate for alternatives to the conventional criteria used to evaluate faculty performance. Successful examples can demonstrate that creative approaches such as service-learning are quite valid – sometimes even more so – than usual instruction. An added incentive, faculty who participate in service-learning often find it more rewarding and become reinvigorated as educators and researchers (Holder et al, 2008; Pribbenow, 2005). Future research is needed to refine understanding of long-term effects of service-learning on students' critical, ecological and civic literacy and ecological economic knowledge.

It is also important to note the limitations of service-learning. To begin, although service-learning often receives high support across the academy, budgets do not reflect this: less than 50% of all service-learning directors are full-time, and nearly half of all service-learning offices have budgets below \$20,000 (Campus Compact, 2004). There may also be real pedagogical limits to infusing service-learning in quantitatively-based disciplines (Butin, 2006; Neumann and Becher, 2002). The changing demographics of higher-education students, moving from “traditional full-time, single, non-indebted and childless students” to a population that is part-time, that has children and needs to earn a

living wage, may also affect how much time can be devoted to service-learning classes (Butin, 2006, p. 9; Henry, 2005). Faculty might also spend less time preparing course content as they assume that more time will be taken up with the service-learning project (Furco, 2001). Further, particular to the environmental field, there may be more of an emphasis on the social science side, possibly neglecting rigorous natural science focus. These limitations can be overcome, however, as service-learning becomes more supported and institutionalized in higher education.

As universities as well as federal, state and local entities and institutions of higher learning make decisions about service-learning funding and program development, emphasis should be placed on the positive role of this pedagogical approach. EE is specially poised to lead the educational reform on campuses needed to develop informed and complex thinkers to take on the myriad problems of the twenty-first century. Freire explains that “knowledge emerges only through invention and re-invention, through the restless, impatient, continuing, hopeful inquiry human beings pursue in the world, with the world, and with each other”. Service-learning provides the building blocks for students, faculty and communities to collectively participate in this vital process.

References

- Anderson, C.W., 1993. *Preserving the Life of the Mind*. University of Wisconsin Press, Madison.
- Anderson, G.L. and Irvine, P., 1993. Informing critical literacy with ethnography. In: Lankshear, C. and McLaren, P. (Eds.), *Critical Literacy: Radical and Postmodernist Perspectives*. State University of New York Press, Albany.
- Astin, A.W.a.S., L.J., 1998. How undergraduates are affected by service participation. *Journal of College Student Development*, 39(3): 251-263.
- Astin, A.W., Vogelgesang, L.J., Ikeda, E.K. and Yee, J.A., 2000. *How Service Learning Affects Students*. Higher Education Research Institute, University of California Los Angeles, Los Angeles, CA.
- Bellinger, G. 2004. *Systems Thinking: An Operational Perspective of the Universe*. <http://www.systems-thinking.org/systhink/systhink.htm>, accessed on May 5, 2008.
- Breiger, R. (2004). The Analysis of Social Networks. *Handbook of Data Analysis*. Hardy, M. and Bryman, A. Sage Publications: 505-526.
- Bowers, C.A., 2001a. *Educating for Eco-Justice and Community*. The University of Georgia Press, Athens.
- Bowers, C.A., 2001b. Toward an eco-justice pedagogy. *Educational Studies*, 32(4): 401-416.
- Butin, D.W., 2006. The limits of service-learning in higher education. *The Review of Higher Education*, 29(4): 473-498.
- Campell, D.E., 2000. Social capital and service learning. *Political Science and Politics*, 33(3): 614-645.
- Campus Compact. (2004). 2003 service statistics: Highlights of Campus Compact's annual membership survey. Available at: http://www.compact.org/news-cc/2003_Statistics.pdf, accessed December 2008.
- Checkoway, B., 2001. Renewing the civic mission of the American research university. *The Journal of Higher Education*, 72(2): 125-146.
- Costanza, R., 1990. Escaping the overspecialization trap: creating incentives for

transdisciplinary synthesis. In: Clark, M.E., Wawrytko, S.A. (Eds.), *Rethinking the Curriculum toward an Integrated Interdisciplinary College Education*. Greenwood Press, New York.

Cushman, E., 2002. Sustainable Service Learning Programs. *College Composition and Communication*, 54 (1): pp. 40-65.

Daudelin, M. W. (1996). Learning from experience through reflection. *Organizational Dynamics*, 24, 36-48.

Delli Carpini, M.X. and Keeter, S., 2000. What should be learned through service learning? *Political Science and Politics*, 33(3): 635-637.

Disinger, J.F. and Roth, C.E. 1992. Environmental Literacy. *ERIC/CSMEE Digest*. <http://www.ericse.org/digests/dse92-1.html>, accessed June 2008.

Driscoll, A.H., G., Gelmon, S. and Kerrigan, S., 1996. An assessment model for service-learning: Comprehensive cases studies of impact on faculty, students, community and institution. *Michigan Journal of Community Service Learning*, 3: 66-71.

England, R.W., 1998. Measurement of social well-being: alternatives to gross domestic product. *Ecological Economics*, 25: 89-103.

Environmental Education and Training Partnership (EETP). 2004. Environmental Literacy. http://eetap.org/html/environmental_literacy.php, accessed June 2008.

Eyler, J. 2000. What do we most need to know about the impact of service-learning on student learning? *Michigan Journal of Community Service Learning*, Special Issue.

Eyler, J. and Giles, D. (Editors), 2001. *At A Glance: What We Know About the Effects of Service- Learning on College Students, Faculty, Institutions, and Communities*, 1993-2000: Third Edition. Corporation for National and Community Service, Washington, DC.

Freire, P., 1970. *Pedagogy of the Oppressed*. Continuum Publishing Company, New York, NY.

Funtowicz, Silvio and Jerry Ravetz. 2007. Post-normal science. *International Society for Ecological Economists* (Content Partner); Robert Costanza (Topic Editor). In: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment).

Funtowicz, S.O. and Ravetz, J. 1994. The Worth of a Songbird: Ecological Economics as a Post-normal science. *Ecological Economics*, 10: 197- 207.

- Furco, A. (2001). Advancing service-learning at research universities. In M. Carada & B. W. Speck (Eds.), *Developing and implementing service-learning programs*. New Directions for Higher Education (No. 114, pp. 67–68). San Francisco: Jossey-Bass.
- Furman, G.C., Gruenewald, D.A., 2004. Expanding the landscape of social justice: a critical ecological analysis. *Educational Administration Quarterly*, 40(1): 47-76.
- Glaser, B.G., 1998. *Doing Grounded Theory: Issues and Discussions*. Sociology Press, Mill Valley, CA.
- Golde, C.M. and Gallagher, H.A., 1999. The challenges of conducting interdisciplinary research in traditional doctoral programs. *Ecosystems*, 2: 281-285.
- Guth, J.H., 2008. *Law for the Ecological Age, Science and Environmental Health Network*.
- Hammer, M. and Söderqvist, T., 2001. Enhancing transdisciplinary dialogue in curricula development. *Ecological Economics*, 38: 1-5.
- Harkavy, I., 2000. Service-learning, academically based community service, and the historic mission of the American urban research university. In: Harkavy, I and Donovan, B.M. (Editors), *Connecting Past and Present: Concepts and Models for Service-Learning in History*. Series on Service-Learning in the Disciplines. American Association for Higher Education, Washington, DC.
- Henry, S.E., 2005. “I can never turn my back on that”: Liminality and the impact of class on service-learning experiences. In: D.W. Butin (Editor), *Service-learning in higher education: Critical issues and directions*. Palgrave, New York, pp. 45–66.
- Holden, M., Elverum, D., Nesbit, S., Robinson, J. Yen, D. and Moore, J., 2008. Learning teaching in the sustainability classroom. *Ecological Economics*, 64: 521-533.
- Honeycutt, J.M., 2002. Outcomes of service-learning in a family communications course. *Academic Exchange Quarterly*, 6(4): 131-135.
- Hsu, S.J. and Roth, R.E. 1998. An assessment of environmental literacy and analysis of predictors of responsible environmental behavior held by secondary teachers in the Huiien area of Taiwan. *Environmental Education Research*, 4(3): 1350-4622.
- Illich, I., 1968. To hell with good intentions. In: N.S.f.E. Education (Editor), *Service Learning Reader: Reflections and Perspectives on Service*.

International Society for Ecological Economics. 2008. Available at <http://www.ecoeco.org/index.php>, accessed on May 13, 2008.

Jackson, M.C. 1991. The origins and nature of critical systems thinking. *System Practice and Action Research*, 4(2): 131-149.

Jacoby, B. and Associates, 1996. *Service Learning in Higher Education: Concepts and Practices*. Jossey-Bass, Inc., San Francisco, CA.

Jacoby, B., 1996. Foundations and principles of service-learning In: Jacoby, B. and Associates (Editors), *Service-learning in Higher Education*. Jossey-Bass, Inc., San Francisco, CA.

Keith, N.Z., 2005. Community service learning in the face of globalization: rethinking theory and practice. *Michigan Journal of Community Service Learning*, 11(2): 5-24.

Kendall, J.C., 1990. *Combining Service and Learning: An Introduction, Combining Service and Learning: A Resource Book for Community and Public Service*. National Society for Experiential Education, Raleigh, N.C.

Kennedy, D., 1997. *Academic Duty*. Harvard University Press, Cambridge.

Keohane, N.O., 1993. The mission of the research university. *Daedalus*, 122(4): 101-126.

Koliba, C.J., 2003. Generating social capital in schools through service-learning. *Academic Exchange Quarterly*, 7.2: 336-345.

Kraft, R. J. 1996. Service Learning: An introduction to its theory, practice, and effects. *Education and Urban Society*, 28: 131-159.

Lankshear, C.a.M., P., 1993. Introduction. In: Lankshear, C. and McLaren, P. (Eds.), *Critical Literacy: Radical and Postmodernist Perspectives*. State University of New York Press, Albany.

Lieberman, G.A.a.H., L.L., 1998. *The Achievement Gap: Using the Environment as an Integrating Context for Learning*. State Education and Environment Roundtable.

Lintoot, J., 1995. Environmental accounting: useful to whom and for what? *Ecological Economics*, 16: 179-190.

Lucas, C., 1994. *American Higher Education: A History*. St. Martin's Griffin, New York.

- Luke, A., and Freebody, P., 1997. Shaping the social practices of reading. In: A. Muspratt, A., Luke, A. and Freebody, P. (Eds.), *Constructing Critical Literacies*. Hampton Press, Cresskill, NJ.
- Madigan, P., 2000. The Environmental Service-learning Research Project, Washington, D.C.
- Max-Neef, M.a., 2005. Foundations of transdisciplinarity. *Ecological Economics*, 53: 5-16.
- Milner, H., 2002. *Civic Literacy: How Informed Citizens Make Democracy Work*. University Press of New England, Hanover, NH.
- Nicolescu, B., 2005. Towards transdisciplinary education and learning, Conference Proceedings for Science and Religion: Global Perspectives Conference, held in Philadelphia, PA, USA, June 4-8, 2005.
- Nicolescu, B., 2002a. *Manifesto of Transdisciplinarity*. State University of New York Press, Albany.
- Nicolescu, B., 2002b. Levels of reality and the sacred, *Foundations and the Ontological Quest: Prospects for the New Millennium*, Pontifica Universitas Lateranensis, Vatican.
- Nicolescu, B., 1997. The transdisciplinary evolution of the university condition for sustainable development, International Congress "Universities' Responsibilities to Society: International Association of Universities, Chulalongkorn University, Bangkok, Thailand.
- National Commission on Civic Renewal, 1998. *A Nation of Spectators: How Civic Disengagement Weakens America and What We Can Do About it*. University of Maryland, College Park, MD.
- Niemi, R. and Junn, J., 1999. *Civic Education: What Makes Students Learn?* Yale University Press, New Haven, CT.
- Neumann, R., & Becher, T. (2002). Teaching and learning in their disciplinary contexts: A conceptual analysis. *Studies in Higher Education*, 27(4), 405–417.
- Orr, D., 2004. *Earth in Mind*. Island Press, Washington, D.C.
- Partnership for 21st Century Skills, 2004. "Definition of Terms," available at: http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=258&Itemid=126, accessed on May 10, 2008.

Pickett, S.T.A., Burch, W.R., Grove, J.M., 1999. Interdisciplinary research: maintaining the constructive impulse in a culture of criticism. *Ecosystems*, 2: 302-307.

Pribbenow, D.A., 2005. The impact of service-learning pedagogy on faculty teaching and learning. *Michigan Journal of Community Service Learning*, 11(2): 25-38.

Richmond, B. 2005. "Systems thinking and the *STELLA* software: Thinking, communicating, learning and acting more effectively in the new millennium," *An Introduction to Systems Thinking, STELLA*. Cleveland, Ohio: International Society for Ecological Economics.

Senge, P. 1990. *The Fifth Discipline*. New York, New York: Doubleday.

Söderbaum, P., 1999. Values, ideology and politics in ecological economics. *Ecological Economics*, 28:161-170.

Spence, D.B., 2001. The shadow of the rational polluter: rethinking the role of rational actor models in environmental law. *California Law Review* 1-57.

Titlebaum, P., Williamson, G., Daprano, C., Baer, J. and Brahler, J., 2004. Annotated History of Service Learning: 1862-2002. http://servicelearning.org/filemanager/download/142/SL%20Comp%20Timeline%203-15-04_rev.pdf, accessed July 2008.

Tomer, J.F. and Sadler, T.R., 2007. Why we need a commitment approach to environmental policy. *Ecological Economics*, 62: 627-636.

Turner, M.G. and Carpenter, S.R., 1999. Tips and traps in interdisciplinary research. *Ecosystems*, 2: 275-276.

Vasquez, V., 2000. Our way: Using the everyday to create a critical literacy curriculum. *Primary Voices*, 9(2): 8-13.

Weisskirch, R.S., 2003. Analyzing student journals in a service-learning course. *Academic Exchange Quarterly*, 7(2): 141-146.

CHAPTER 6: CONCLUSIONS

1. Implications

In *Hunting for Hope* Scott Sanders (1998) talks about the need to make peace with both the past and the future in order to tackle the complex and multifaceted problems of today's world, particularly regarding the environment. This echoes the call of ecological economics to move beyond scary gloom-and-doom rhetoric to get down to the business of facilitating people to form pro-environmental behaviors through envisioning a better, more sustainable future for all.

Stern (2000) defines environmentally significant behavior as: "the extent to which it changes the availability of materials or energy from the environment or alters the structure and dynamics of ecosystems or the biosphere," (p. 408) both directly and indirectly. Pro-environmental behavior, therefore, is the ability to take into consideration the effects of individual actions on the environment and act in a way that produces the least harm/actively generates positive impact. The intermediate ends of systems thinking, developing ecological literacy and capacity building in society, are vital to inform this behavior change. In this way, capacity building can be considered a tool and an end, because as citizens augment their ecosystem competence, systems thinking and ecological literacy can be generated. Environmentally-sound behavior is the result of a capable citizenry. The tools introduced in this research aim to build capacity for wide-ranging problem-solving and decision-making.

From scholars such as David Orr, E.O. Wilson, Rachel Carson and David Sobel, there has been a call to action to develop a deep-seated understanding of human's role as

part of the planet's ecosystem in order to produce pro-environmental behavior. In order to do this, understanding of complex systems is vital; once we grasp an understanding of the intricate and multifarious workings of the Earth, we can begin to develop systems thinking, which is in turn essential to develop ecological literacy. A complex system can be thought of as “a system with a large number of elements, building blocks or agents, capable of interacting with each other and their environment...the common characteristic of all complex systems is that they display organization without any external organizing principle being applied” (NICO, 2007). As history evidences, there is not a silver bullet or infallible recipe to success to acquire systems thinking, understand complex systems, or facilitate capacity building and ecological literacy that will ultimately lead to sound ecosystem management and sustainable development. We do have some frameworks, however, that provide sound structure to help us get there.

2. Answering the Research Questions

This dissertation research investigated if ecosystem services valuation, payments for ecosystem services and service-learning can be considered useful frameworks for ecosystem management and sustainable development and if they offer applied approaches for ecological economics outreach. This work aimed to answer several research questions and there are several findings that highlight the importance of and areas of improvement for integrating such tools in a comprehensive sustainable development approach.

1) How can the use of rapid assessment for ecosystem services valuation be used to promote public participation and integrate systems thinking into decision-making about large-scale development projects? How can this method incorporate indigenous and local knowledge (human capital) in a manner that ensures long-term natural capital health?

Ecosystem services valuation, which assigns economic values to the benefits humans derive from natural environments, is a framework that can provide vital insight into the ecological costs of large-scale land development projects. While the methodology should continue to be refined, the approach that we offer, rapid assessment valuation, explicitly builds in space for a plurality of perspectives on how to evaluate ecosystem health and values. Through means such as participatory meetings and Delphi surveys, stakeholders, including scientific experts, indigenous groups and others involved in the process can provide input on setting the parameters used in the RAV. Participation in this type of interactive process, one that illuminates each ecosystem service and their connections with biomes, can engender enhanced understanding of systems and how they work. This method, coupled with long-term outreach and education strategies, can go far in increasing systems thinking.

To ensure the health of natural capital in the long-term, particularly in areas in which large infrastructure projects are being considered or implemented, RAV should be one component of a multi-pronged decision-making and monitoring approach. Implementing a sustainable development framework, that simultaneously measures environmental, social and economic sustainability criteria, can be used as a starting point for this comprehensive approach. Periodically engaging in an ESV process to identify

any changes in ecosystem health and/or service provision, can be a critical element of this determining environmental sustainability.

When thinking about how to proceed with development decisions, some focal points can be identified:

- Implement an ecological economic perspective, with equal considerations on economic, social and environmental sustainability.
- Develop a full range of alternatives, including not proceeding with the project, to gain a true comprehension of the potential risks and benefits of any project.
- Use indigenous/local knowledge for true information transfer to facilitate genuine understanding of the project area.
- Incorporate the knowledge gained in this information transfer by employing ecosystem services valuation to identify the true impacts to natural systems in order to make a fully informed decision about the project. This will allow for thorough comprehension of not only the direct impacts of the project, but how the health of these systems will be impacted by indirect and long-term influences as well. Within this framework, human well-being will also be considered, as ecosystem health is a vital component to human life.
- Utilize the precautionary principle as a guiding precept, to provide space for recognition of the possibility of accidents and crisis response development (e.g. pipeline ruptures).
- Have transparency in every step of the process and establish accountability mechanisms to ensure compliance with project agreements.

- Allow for as much participation as possible, in order to incorporate for a multitude of perspectives that will necessarily highlight the myriad components involved in any development project.
- Employ post-normal science as a mechanism for development, application, evaluation, continued research, reflection and reassessment
- Always consider impacts to future generations

2) Are payment for ecosystem services programs successful at managing natural capital? What are important variables for long-term participation for small landowners in payments for ecosystem services programs? Do payment for ecosystem service programs adequately take into account the role of ecological literacy and the importance of just distribution for poor participants? What is the role (if any) of social capital in increasing participant retention?

The in-depth analysis of Costa Rica's payments for ecosystem services program demonstrates that PES is an effective market-based instrument for forest conservation and regeneration in developing countries. Several areas of improvement were also identified for such programs to increase efficiency. However, in order for such programs to also be effective mechanisms to achieve socioeconomic goals such as poverty alleviation, several points must be addressed. First, it must be recognized that poor participants face serious trade-offs in compromising potential income derived from competing land uses. This loss in revenue may contribute to reduced QOL from an economic perspective, but may increase other facets of QOL, such as emotional

happiness derived from access to nature. Next, depending on community perceptions of PES, participant involvement in such programs may negatively affect social capital in the community. Moreover, the amount of institutional support can play an important role in participant retention. Participants may have elevated levels of ecological literacy, which influences their decision to belong to the program. In order to develop ecoliteracy levels in the community, specifically targeting those with lower ecoliteracy would go far to promote equity. PES program development and improvements should take into account the following considerations:

- Recognize the potential for institutionalized bias toward the forestry sector (which may promote plantations) in program design and ensure that all modalities receive equal consideration
- Develop monitoring systems that are transparent and do not rely on participant transaction fees
- Design payment schemes to adequately reflect market prices for land use, and justly compensate for opportunity costs
- Build in long-term funding mechanisms in program design to address issues of free riding and program sustainability
- Set explicit conservation and socioeconomic objectives, construct particular criteria to measure them, and develop program to ensure compliance with these goals

3) Does service-learning enhance systems thinking (and human capital) in students? What elements are successful and what are areas of improvement to better implement service-learning in ecological economic curricula?

Service-learning, or working with communities to address real world-problems through a rigorous academic framework, can be an important tool in developing critical, ecological and civic literacy in students and creating more knowledgeable agents to solve the world's complex problems. The service-learning courses that were studied clearly contributed to students' critical, ecological and civic literacy in a way that most likely would not have been attained in the classroom. Comprehension of complex problems and systems thinking was enhanced through applied problem solving with community partners, positively contributing to development of the CECL EE student. When designing ecological economic curricula, there are several areas of importance to consider:

- Significant commitment of time, resources and energy are needed to promote trust between university and community partners
- Traditional course demands are not always aligned with service-learning course requirements, which can potentially affect promotion and tenure considerations
- Civic, critical and ecological literacy can be further enhanced in students through course content

- Institutional support can play an important role for course development, identifying and establishing partner relationships, and assisting in designing the service experience to meet specific needs

Evaluating the Tools

The three approaches analyzed in this dissertation indicate that there are certain strengths and area of improvements for each one. The overall focus of this research also aims to determine if the tools investigated in this research are useful for ecosystem management and sustainable development. In order to ascertain this, specific criteria for each facet of environmental, social and economic sustainability should first be elucidated. For purposes of this discussion, crafting such criteria is not an attempt at being all-inclusive. As Sen (1992) and others (see Alkire, 2002 and MaxNeef, 1993) have pointed out, there are numerous problems associated with developing an exhaustive list of dimensions of sustainability, including being Western-biased, overly specific and therefore exclusive, as well as value-laden and too prescriptive (Alkire, 2002). Instead, criteria designated for this assessment will most closely pertain to the topics investigated in this research. Criteria will therefore be based upon the three core foundations in the sustainable development framework that take an ecological economic approach: environmental, social and economic sustainability. Within those categories, particular focal points are:

Environmental Sustainability:

- Source and sink functioning – practices ensure that the natural capital stock remains intact and source and sink functions of the environment are not degraded
- Ecosystem health is not affected – land use changes will not adversely impact overall ecosystem health
- Ecosystem services provisioning – land use changes will not affect the continued provisioning of ecosystem services

Social Sustainability:

- Institutions – institutions that provide adequate support for its citizenry
- Social capital – practices ensure the cohesion of society and its ability to work towards common goals and benefits social capital
- Individuals' needs are met – health, well-being, nutrition, shelter, education and cultural expression needs are met
- Ecological literacy – practices work toward cultivating systems-thinking and ecological literacy on individual and/or community levels

Economic Sustainability:

- Adhere to biophysical limits – economic growth happens only within biophysical limits and adheres to the laws of thermodynamics
- Efficient allocation and just distribution – economic resources are managed with allocation and distribution considerations

Table 6-1 indicates how each tool contributes to each facet of sustainability.

Tool	Environmental Sustainability			Social Sustainability				Economic Sustainability		
	Source and sink ecosystem functioning not degraded	Ecosystem health is not adversely affected	Ecosystem services provisioning is not affected	Beneficial impacts on social capital	High level of institutional support	Ecological literacy developed	Individual needs are met	Growth within biophysical limits	Financially feasible	Efficient allocation and just distribution incorporated
Rapid Assessment Valuation	√	√	√	*	*	*	*	√	√	*
Payments for Ecosystem Services	√	√	√	*	*	*	◇	◇	*	◇
Service-learning	*	*	*	*	*	√	√	*	√	*

Table 6-1: Evaluation of Tools as they fit into an Ecological Economic Framework

(√) – condition being met if tool is properly implemented

(*) – potential for condition to be met, depending on the circumstance

(◇) – tool design or implementation needs improvement to meet condition

Table 6-1 demonstrates that while all tools are currently meeting some criteria and have the potential to meet more, no one tool is able to meet all conditions. This verifies that there is no panacea to both ecosystem management and sustainable development. Instead, as endorsed in ecological economics and post-normal science, there should be a multi-pronged approach, just as environmental problems are multifaceted. Concurrent implementation of several tools, with regular monitoring and assessment, as prescribed in post-normal science, builds a more thorough framework for enhanced management and development.

3. Future Research

The results in this dissertation research highlight that while the three tools are effective, there is even more to learn about the nuances of each one. Ecosystem service valuation continues to be a controversial but increasingly more acceptable method for policy and decision-making. Whilst there are calls to develop a universal valuation method, it is also important to acknowledge that every situation in which ESV is used has its own conditions that need to be considered. The framework we present attempts to build in space for individualization. Further research can consider how to refine methodologies for participation and expert input for assessing ecosystem health and range of values. More work also needs to be done to examine the implications that ESV has on policy-making and implementation. Perhaps most importantly, inquiry needs to be made to determine how, once ESV assessments are made, modified or alternative programs can be put into place that also engender economic and social development.

Programs such as PES provide promise as an alternative option to development. While they hold great potential for forestry conservation, studies that analyze how socioeconomic goals, such as poverty alleviation, can be more successfully met, are necessary. Investigation of complimentary programs, to use concomitantly with PES, that explicitly seek to meet development goals, is also important.

Tools that also develop more sophisticated decision-makers are vital in a wide-ranging sustainability framework. Research that probes how service-learning can be incorporated into ecological economic curricula will go far in refining its applications. Exploration into how service-learning affects long-term student outcomes, as well as its effect on faculty, is also needed to enhance understanding of service-learning use and applications.

4. Final Thoughts

Overall, this work demonstrates that ecological economics can be instrumental in accentuating the other capitals – social, natural and human – that have been diminished by the neo-classical economic emphasis on built capital. This research highlights the importance that all forms of capital bring to understanding systems-thinking for sound ecosystem management. As the definitions for sustainable development and sustainability, weak, strong and otherwise, continue to be refined, recognizing the unique contributions that natural, social and human capital make toward quality of life and human well-being, are essential to ensure long-term viability.

Comprehensive Literature Cited

- Alkire, S., 2000. The basic dimensions of human flourishing: a comparison of accounts. In: N. Biggar, Black, R. (eds.), *The Revival of Natural Law: Philosophical, Theological and Ethical Responses to the Finnis-Griesz School*. Aldershot, Ashgate.
- Alterman, R. 1982. Planning for Public Participation: The Design of Implementable Strategies. *Environment and Planning B*. 9, 295-313
- Amador, J.A., Laporte, S., Chacon, R.E., 2000. Cuenca del Rio Arenal: analisis del los eventos Nino de los anos 1992-93, 1994-95 y 1997-98. *Temas Meteorologicos y Oceanograficos* 7(1), 1-20.
- Amazon Alliance, 2004, The Camisea Project. Accessed October – December 10, 2007, from <http://amazonalliance.org/camisea.html>.
- Amazon Watch, 2006. Camisea Natural Gas Project. Accessed on January 30, 2008. <http://amazonwatch.org/amazon/PE/camisea/>.
- Anderson, C.W., 1993. *Preserving the Life of the Mind*. University of Wisconsin Press, Madison.
- Anderson, G.L. and Irvine. P., 1993. Informing critical literacy with ethnography. In: Lankshear, C. and McLaren, P. (Eds.), *Critical Literacy: Radical and Postmodernist Perspectives*. State University of New York Press, Albany
- Ando, A., Camm, J., Polasky, S., Solow, A., 1998. Species distributions, land values, and efficient conservation. *Science*, 279: 2126-2128.
- Arroyo-Mora, J. P., Sanchez-Azofeifa, G. A., Rivard, B., Calvo, J. C., Janzen, D. H., 2005. Dynamics in landscape structure and composition for the chorotega region, costa rica from 1960 to 2000. *Agriculture Ecosystems & Environment* 106, 27-39.
- Astin, A.W. and Sax, L.J., 1998. How undergraduates are affected by service participation. *Journal of College Student Development*, 39(3): 251-263.
- Astin, A.W., Vogelgesang, L.J., Ikeda, E.K. and Yee, J.A., 2000. *How Service Learning Affects Students*. Higher Education Research Institute, University of California Los Angeles, Los Angeles, CA.
- Avalos, A.R., 2007. Ice suspende coretes de electricidad en todo el pais. *La Nacion*. Sabado 5 de mayo. Available at: http://www.nacion.com/ln_ee/2007/mayo/05/pais1085589.html, accessed on May 5,

2007.

Ayuk, E. T., 1997. Adoption of agroforestry technology: The case of live hedges in the central plateau of Burkina Faso. *Agricultural Systems* 54, 189-206.

Babcock, B.A., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1996. The economics of a public fund for environmental amenities: A study of CRP contracts. *American Journal of Agricultural Economics*, 78: 961-971.

Babcock, P.G., Lakshminarayan, P.G., Wu, J., Zilberman, D., 1997. Targeting tools for the purchase of environmental amenities. *Land Economics*, 73 (3): 325-339.

Bank Information Center (BIC). 2008. Environmental Policy at the IDB. Accessed on February 15, 2008. <http://www.bicusa.org/en/Issue.35.aspx>.

Baumert, K., Herzog, T., Pershing, J., 2005. Navigating the numbers: greenhouse gas data and international climate policy. 122 pages, World Resources Institute, Washington D.C., USA.

Becker, C. 2006. The Human Actor in Ecological Economics: Philosophical Approach and Research Perspectives. *Ecological Economics*. 60, 17-23.

Beier, C., Patterson, T., in review. Targeted social-ecological vulnerability at the landscape scale: ecosystem services, social importance and disturbance. Submitted to *Ecosystems*.

Beirele, T.C. and Cayford, J. 2002. *Democracy in Practice: Public Participation in Environmental Decisions*. Washington, D.C.: Resources for the Future Press.

Bellinger, G. 2004. *Systems Thinking: An Operational Perspective of the Universe*. <http://www.systems-thinking.org/systhink/systhink.htm>, accessed on May 5, 2008.

Bengston, D.N., Youn, Y.C., 2006. Urban containment policies and the protection of natural areas: The case of Seoul's greenbelt. *Ecology and Society*, 11, 3.

Berentsen, B.M., Hendriksen, A., Heijman, W., van Vlokhoven, H., 2007. Costs and benefits of on-farm nature conservation. *Ecological Economics*, 62, 571-579.

Biesanz, R., Biesanz, K.Z., Biesanz, M.H., 1982. *The Costa Ricans*. Waveland Press, Prospect Heights, IL.

Bodorkos, B., Balazs, B., Bela, G. and Pataki, G. 2005. Community-based Sustainability Planning in the South-Borsod Region, Hungary. Paper for the 7th Conference of the European Sociological Association, 9-12 September, 2005, Torun, Poland.

Bowers, C.A., 2001a. *Educating for Eco-Justice and Community*. The University of Georgia Press, Athens.

Bowers, C.A., 2001b. Toward an eco-justice pedagogy. *Educational Studies*, 32(4): 401-416.

Brennan, A., 1995. Ethics, ecology and economics. *Biodiversity and Conservation*, 4 (8): 798-811.

Brehm, J. and Rahn, W. 1997. Individual-Level Evidence for the Causes and Consequences of Social Capital. *American Journal of Political Science*. 41, 999-1023.

Breiger, R. (2004). The Analysis of Social Networks. Handbook of Data Analysis. Hardy, M. and Bryman, A. Sage Publications: 505-526.

Brockett C., Gottfried, R., 2002. State policies and the preservation of forest cover: lessons from contrasting public-policy regimes in Costa Rica. *Latin American Research Review*, 37(1), 7-40.

Brown, P.M. and Cameron, L.D. 2000. What can be done to reduce overconsumption? *Ecological Economics*. 32, 27- 41.

Bruijnzeel, L.A., 2004. Hydrological functions of tropical forests: Not seeing the soil for the trees? *Agriculture, Ecosystems, and Environment*, 104, 185-228.

Bruijnzeel, L.A., 2006. Cloud forests, hydrology and payment for Ecosystem Services in Costa Rica. Available at:
http://www.iucn.org/themes/cem/news/newsletter/2006/cem_newsletter03_2006.htm,
accessed on June 27, 2007.

Butin, D.W., 2006. The limits of service-learning in higher education. *The Review of Higher Education*, 29(4): 473-498.

Caffrey, P.B., 2002. An Independent and Social Assessment of the Camisea Gas Project. Bank Information Center.

Camacho, S.M.A., Segura Bonilla, O., Reyes Gatjens, V., Miranda Quiros, M., 2002. *Gestion local y participacion en torno al pago por servicios ambientales: Estudios de caso en Costa Rica*, Centro Internacional de la Politica Economia, CINPE, San Jose, Costa Rica.

Campell, D.E., 2000. Social capital and service learning. *Political Science and Politics*, 33(3): 614-645.

Carpenter, S.R., DeFries, R., Dietz, T., Mooney, H.A., Polasky, S., Reid, W.V., Scholes, R.J., 2006. Millennium ecosystem assessment: research needs. *Science*. 314, 257-258.

Castillo, E.A., 2006. Proyecto Ecomercdos: Consultoria Para Actualizacion de la Propuesta Technica de Ordenamiento Territorial Con Fines de Conservacion de Biodiversidad en Costa Rica (GRUAS II).

Chambers, R., Conway, G., 1992. Sustainable rural livelihoods; practical concepts for the 21st century. IDS Discussion Paper 296, Institute of Development Studies, Brighton, England.

Checkoway, B., 2001. Renewing the civic mission of the American research university. *The Journal of Higher Education*, 72(2): 125-146.

Chichilnisky, G., Heal, G. 1998. Economic returns from the biosphere. *Nature*. 391, 628-629.

Chomitz, K. M., Brenes, E., Constantino, L., 1999. Financing environmental services: The costa rican experience and its implications. *Science of the Total Environment* 240, 157-169.

Chomitz, K.M., Fonseca, G.A.B., Alger, K., Stoms, D.M., Honzák, M., Landau, E.C., Thomas, T.S., Thomas, W.W., Davis, F., 2006. Viable reserve networks arise from individual landholder responses to conservation initiatives. *Ecology and Society* 11, 40.

CIA, 2007. The World Fact Book – Costa Rica. Available at <https://www.cia.gov/cia/publications/factbook/geos/cs.html>, accessed on May 2, 2007.

CIFOR,1999. Your subsidies are my incentives. POLEX. Available at <http://www.cifor.cgiar.org/Publications/Polex/polexdetail.htm?pid=19>, accessed on December 18, 2006.

Cincotta, R.P., Wisnewski, J. and Engelman, R., 2000. Human population in the biodiversity hotspots. *Nature*, 404(6781), 990-992.

Conservation International, (CI) 2007. Biodiversity hotspots: tropical Andes. <http://www.biodiversityhotspots.org/xp/hotspots/andes/Pages/default.aspx>, accessed on February 1, 2008,

Costanza, R. and Farley, J., Forthcoming. Introduction: Theory and Practice of Payments for Ecosystem Services: The Heredia Declaration. *Ecological Economics*.

Costanza, R., 2001. Visions, values, valuation, and the need for an Ecological Economics. *BioScience* 51 (6), 459-468.

Costanza, R., 1990. Escaping the overspecialization trap: creating incentives for transdisciplinary synthesis. In: Clark, M.E., Wawrytko, S.A. (Eds.), *Rethinking the Curriculum Toward an Integrated Interdisciplinary College Education*. Greenwood Press, New York.

Costanza, R. 1989. What is Ecological Economics? *Ecological Economics* 1(1), 1-7.

Costanza, R. and Ruth, M. 1998. Using dynamic modeling to scope environmental problems and build consensus. *Environmental Management*, 22(2), 183-195.

Costanza, R., Cumberland, J., Daly, H., Goodland, R., and Norgaard, R. 1997a. *An Introduction To Ecological Economics*. Boca Raton, FL: St. Lucie Press.

Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M. 1997b. The value of the world's ecosystem services and natural capital. *Nature*. 387: 253-260.

Creswell, J.W. 2003. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. (2nd ed.) Thousand Oaks: Sage.

Critchley, W.R.S. 1999. Harnessing traditional knowledge for better land husbandry in Kabale District Uganda. *Mountain Research and Development*. 19, 261-272.

Cushman, E., 2002. Sustainable Service Learning Programs. *College Composition and Communication*, 54 (1): pp. 40-65.

Daily, G.C. (ed.) 1997. *Natures Services: Societal Dependence on Natural Ecosystems*. Washington, D.C.: Island Press.

Daly, H.E. and Farley, J. 2004. *Ecological Economics: Principles and Applications*. Washington, DC: Island Press.

Dandaneau, S.P. 2001. *Taking It Big: Developing Sociological Consciousness in Postmodern Times*. Thousand Oaks, California: Pine Forge Press.

Daniels, A., Esposito, V., Bagstad, K., Moulaert, A., Rodriguez, C.M., Segura-Bonilla, O. In Preparation. A decade of PES: Building on Costa Rica's model and applying lessons learned. Submitted

Daudelin, M. W. (1996). Learning from experience through reflection. *Organizational Dynamics*, 24, 36-48.

De Camino, R., Segura, O., Arias, L.G., Pérez, I., 2002. Costa Rica: Forest Strategy and the Evolution of Land Use. World Bank Evaluation Country Case Study. Series 148. The World Bank, Washington, DC.

de Groot, R. S., Wilson, M.A, Boumans, R.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics*. 41(3), 393-408.

Delli Carpini, M.X. and Keeter, S., 2000. What should be learned through service learning? *Political Science and Politics*, 33(3): 635-637.

Disinger, J.F. and Roth, C.E. 1992. *Environmental Literacy*. ERIC/CSMEE Digest. <http://www.ericse.org/digests/dse92-1.html>, accessed September 2006.

Driscoll, A.H., G., Gelmon, S. and Kerrigan, S., 1996. An assessment model for service-learning: Comprehensive cases studies of impact on faculty, students, community and institution. *Michigan Journal of Community Service Learning*, 3: 66-71.

Easterlin, R.A. 2003. "Building a better theory of well-being", Discussion Paper No. 742. Bonn, Germany: IZA Bonn.

ECLAC (2004). *A decade of social development in Latin America, 1990-1999*. United Nations Economic Commission for Latin America and the Caribbean. Chile, Santiago.

Economist, 2008. There is hope. *The Economist* 389(8601), 1.

Economist, 2005. Are you being served? *The Economist*. 375(8423), 1.

Energy Information Administration, EIA, 2006a. Annual energy review.

Energy Information Administration, EIA, 2006b. Peru.

England, R.W., 1998. Measurement of social well-being: alternatives to gross domestic product. *Ecological Economics*, 25: 89-103.

Environmental Education and Training Partnership (EETP). 2004. Environmental Literacy. http://eetap.org/html/environmental_literacy.php, accessed October 2006.

Estado de la Nacion, 2006. Duodécimo informe estado de la nacion en desarrollo humano sostenible. Programa Estado de la Nacion, San Jose, Costa Rica. (ISBN: 9968-806-37-4).

European Commission. 2007. *A Sustainable Future in Our Hands*. Brussels, Belgium: European Commission Secretariat-General.

Eyler, J. 2000. What do we most need to know about the impact of service-learning on student learning? *Michigan Journal of Community Service Learning*, Special Issue.

Eyler, J. and Giles, D. (Editors), 2001. *At A Glance: What We Know About the Effects of Service- Learning on College Students, Faculty, Institutions, and Communities*, 1993-2000: Third Edition. Corporation for National and Community Service, Washington, DC.

Farber, S. C., Costanza, R., and Wilson, M.A. , 2002. Economic and ecological concepts for valuing ecosystem services. *Ecological Economics*. 41, 375-392.

Ferraro, P.J., 2001. Global habitat protection: Limitations of development interventions and a role for conservation performance payments. *Conservation Biology* 15 (4), 990-1000.

Flyvbjerg, B. 2006. "Five misunderstandings about case study research." *Qualitative Inquiry*, 12(2): 219-245.

Fonafifo, 2006. Environmental Services Statistics. Fondo Nacional de Financiamiento Nacional, San José, Costa Rica. Webpage <http://www.fonafifo.com>, accessed May 2008.

Fondo Nacional de Financiamiento Forestal (FONAFIFO), 2005. "Servicios Ambientales: Pilares Fundamentales del PPSA," http://www.fonafifo.com/paginas_espanol/servicios_ambientales/servicios_ambientales.htm, accessed on April 18, 2007.

Foster, J. and Gough, S., 2005. *Learning, Natural Capital and Sustainable Development : Options for an Uncertain World*. Routledge, London, New York.

Freire, P., 1970. *Pedagogy of the Oppressed*. Continuum Publishing Company, New York, NY.

Funtowicz, Silvio and Jerry Ravetz. 2007. Post-Normal Science. International Society for Ecological Economists (Content Partner); Robert Costanza (Topic Editor). In: *Encyclopedia of Earth*. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment).

Funtowicz, S.O. and Ravetz, J. 1993. Science for a Post-normal Age. *Futures*. 25, 739-755.

Funtowicz, S.O. and Ravetz, J. 1994. The worth of a songbird: Ecological economics as a Post-normal Science. *Ecological Economics*. 10, 197- 207.

Furco, A. (2001). Advancing service-learning at research universities. In M. Carada & B. W. Speck (Eds.), *Developing and implementing service-learning programs*. New Directions for Higher Education (No. 114, pp. 67–68). San Francisco: Jossey-Bass.

Furman, G.C.a.G., D.A., 2004. Expanding the landscape of social justice: a critical ecological analysis. *Educational Administration Quarterly*, 40(1): 47-76.

García, R., 1996. Propuesta tecnica de ordenamiento territorial con fines de conservacion de biodiversidad: protyecto GRUAS. Ministerio del Ambiente y Energía (MINAE) and sistema Nacional de Areas de Conservacion (SINAC), Costa Rica.

Gilbert, R., Stevenson, R., Girardet, H. and Stern, R., 1996. *Making Cities Work*. Earthscan Publications, United Kingdom.

Glaser, B.G., 1998. *Doing Grounded Theory: Issues and Discussions*. Sociology Press, Mill Valley, CA.

Glaser, B.G., 1978. *Theoretical Sensitivity*. Sociology Press, Mill Valley, CA.

Glesne, C. and Peskin, A. 1992. *Becoming Qualitative Researchers: An Introduction*. White Plains, NY: Longman.

Godoy, R. A., 1992. Determinants of smallholder commercial tree cultivation. *World Development* 20, 713-725.

Golde, C.M. and Gallagher, H.A., 1999. The challenges of conducting interdisciplinary research in traditional doctoral programs. *Ecosystems*, 2: 281-285.

Government of Peru (GoP), 2005. Constitution of Peru.

Grieg-Gran, M., Porras, I., Wunder, S., 2005. How can market mechanisms for forest environmental services help the poor? Preliminary lessons from Latin America. *World Development* 33, 1511-1527.

Grootaert, C. 1999. *Social Capital: The Missing Link?* Social Capital Initiative, Working Paper No. 3. Washington, DC: World Bank.

Guth, J.H., 2008. Law for the Ecological Age, Science and Environmental Health Network.

Hagens, N. 2007. Why we disagree on peak oil and climate change: Part III – Our belief systems. The Oil Drum. Available at <http://www.theoil Drum.com/node/2411>, accessed on June 15, 2007.

Hammer, M. and Söderqvist, T., 2001. Enhancing transdisciplinary dialogue in curricula development. *Ecological Economics*, 38: 1-5.

Harkavy, I., 2000. Service-learning, academically based community service, and the historic mission of the American urban research university. In: Harkavy, I and Donovan, B.M. (Editors), *Connecting Past and Present: Concepts and Models for Service-Learning in History*. Series on Service-Learning in the Disciplines. American Association for Higher Education, Washington, DC.

Hawken, P., Lovins, A. and Lovins, H. 1999. *Natural Capitalism: Creating the Next Industrial Revolution*. Boston: Little, Brown and Co.

Henry, S.E., 2005. "I can never turn my back on that": Liminality and the impact of class on service-learning experiences. In: D.W. Butin (Editor), *Service-learning in higher education: Critical issues and directions*. Palgrave, New York, pp. 45–66.

Herrera Descalzi, C.F., 2006. Assessment on the Camisea Pipeline Project in Peru, Committee on Foreign Relations. United States Senate.

Holden, M., Elverum, D., Nesbit, S., Robinson, J. Yen, D. and Moore, J., 2008. Learning teaching in the sustainability classroom. *Ecological Economics*, 64: 521-533.

Honeycutt, J.M., 2002. Outcomes of service-learning in a family communications course. *Academic Exchange Quarterly*, 6(4): 131-135.

Hope, R.A., Porras, I.T., Miranda, M. 2005. Can Markets for Environmental Services Contribute to Poverty Reduction? A Livelihoods Analysis from Arenal, Costa Rica. Report under the DFID Forestry Research Programme, Project. No. R8174.

Howarth, R. B. and Farber, S., 2002. Accounting for the value of ecosystem services. *Ecological Economics* 41(3), 421-429.

Hsu, S.J. and Roth, R.E. 1998. An Assessment of Environmental Literacy and Analysis of Predictors of Responsible Environmental Behavior Held by Secondary Teachers in the Huiien Area of Taiwan. *Environmental Education Research*. 4(3), 1350-4622.

Hungerford, H. and Volk, T. 1990. Changing Learner Behavior Through Environmental Education. *Journal of Environmental Education*. 21(3), 8-21.

Illich, I., 1968. To hell with good intentions. In: N.S.f.E. Education (Editor), Service Learning Reader: Reflections and Perspectives on Service.

Inter-American Development Bank (IDB), 2005. Camisea Project Overview.

International Geosphere-Biosphere Programme. 2007. "Latest IPCC report highlights need for integrated climate/behavior models." Science Daily.

International Society for Ecological Economics. 2008. Available at <http://www.ecoeco.org/index.php>, accessed on May 13, 2008.

International Rivers Network (IRN). 2000. Brazil's Movement of Dam-Affected People. Available at <http://www.irn.org/wcd/mab.shtml>, accessed on April 17, 2007.

Jackson, M.C. 1991. The origins and nature of critical systems thinking. System Practice and Action Research. 4(2), 131-149.

Jacoby, B., 1996. Foundations and principles of service-learning In: Jacoby, B. and Associates (Editors), *Service-learning in Higher Education*. Jossey-Bass, Inc., San Francisco, CA.

Kasemir, B., Jager, J., Jaeger, C.C., and Gardner, M.T. (eds.). 2003. *Public Participation in Sustainability Science*. Cambridge, MA: Cambridge University Press.

Kasser, T. 2002. *The High Price of Materialism*. Cambridge, MM/London, England: The MIT Press.

Keith, N.Z., 2005. Community service learning in the face of globalization: rethinking theory and practice. Michigan Journal of Community Service Learning, 11(2): 5-24.

Kendall, J.C., 1990. *Combining Service and Learning: An Introduction, Combining Service and Learning: A Resource Book for Community and Public Service*. National Society for Experiential Education, Raleigh, N.C.

Kennedy, D., 1997. *Academic Duty*. Harvard University Press, Cambridge.

Kent, R.J. 2002. History and necessity: The evolution of soil conservation technology in a Jamaican farming system. The Geographical Journal. 168(1), 48-56.

Keohane, N.O., 1993. The mission of the research university. Daedalus, 122(4): 101-126.

Koliba, C.J., 2003. Generating social capital in schools through service-learning. Academic Exchange Quarterly, 7.2: 336-345.

- Kosoy, N., Martinez-Tuna, M., Muradian, R. and Martinez-Alier, J. 2007. Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America. *Ecological Economics*. 61(2-3), 446-455.
- Kraft, R. J. 1996. Service Learning: An introduction to its theory, practice, and effects. *Education and Urban Society*, 28: 131-159.
- Krebs, V. (2007). "Social Network Analysis, A Brief Introduction." 2007, from <http://www.orgnet.com/sna.html>.
- Krysiak, F.C., 2006. Entropy, limits to growth, and the prospects for weak sustainability. *Ecological Economics*, 58(1): 182-191.
- Landell-Mills, N. and Porras, I.T., 2002. Silver bullet or fool's gold? A global review of markets for forest environmental services and their impact on the poor. International Institute for Environment and Development, London.
- Landers, J., 2006. Hunt Oil making big play in Peru: But liquid natural gas faces series of questions. *The Dallas Morning News*, Dallas, TX.
- Lankshear, C.a.M., P., 1993. Introduction. In: Lankshear, C. and McLaren, P. (Eds.), *Critical Literacy: Radical and Postmodernist Perspectives*. State University of New York Press, Albany.
- Lara, S., Barry, T., Simonson, P., 1995. Incide Costa Rica—The essential guide to its politics, economy, society and environment. Resource Center Press. Albuquerque, New Mexico, USA.
- Latacz-Lohmann, U., van der Hamsvoort, C., 1997. Auctioning conservation contracts: A theoretical analysis and an application. *American Journal of Agricultural Economics*, 79 (2): 407-418.
- Latacz-Lohmann, U., Schilizzi, S., 2005. Auctions for conservation contracts: A review of the theoretical and empirical literature. Report to the Scottish Executive Environment and Rural Affairs Department. Project No. UKL/001/05.
- Layard, R. 2005. *Happiness From a New Science*. London, England: Penguin Books.
- Liberman, G.A.a.H., L.L., 1998. The Achievemnt Gap: Using the Environment as an Integrating Context for Learning. State Education and Environment Roundtable.
- Limburg, K. E., O'Neill, R. V., Costanza, R., Farber, S., 2002. Complex systems and valuation. *Ecological Economics*. 41(3), 409-420.

- Lincoln, Y.S. and Guba, E.G. 1985. *Naturalistic Inquiry*. Newbury Park, CA: Sage Publications.
- Lintoot, J., 1995. Environmental accounting: useful to whom and for what? *Ecological Economics*, 16: 179-190.
- Lucas, C., 1994. *American Higher Education: A History*. St. Martin's Griffin, New York.
- Luke, A., and Freebody, P., 1997. Shaping the social practices of reading. In: A. Muspratt, A. Luke, A. and Freebody, P. (Eds.), *Constructing Critical Literacies*. Hampton Press, Cresskill, NJ.
- Lutz, E., Daly, H., 1991. Incentives, regulations and sustainable land use in Costa Rica. *Environmental and Resource Economics*, 1, 179-194.
- MacKenzie-Mohr, D. 2000. Promoting sustainable behavior: An introduction to community-based social marketing. *Journal of Social Issues*. 56(3), 543-554.
- Madigan, P., 2000. The Environmental Service-learning Research Project, Washington, D.C. Marshall, C. and Rossman, G.B., 1999. *Designing Qualitative Research*, 3rd ed. Thousand Oaks, CA: Sage Publications.
- Marshall, C. and Rossman, G.B., 1999. *Designing Qualitative Research*, 3rd ed. Thousand Oaks, CA: Sage Publications.
- Marsik, M., Waylen, P., 2006. An application of the distributed hydrologic model CASC2D to a tropical montane watershed. *Journal of Hydrology* 330, 481-495.
- May, P. H., Neto, F.V., Denardin, V. and Loureiro, W., 2002. Using fiscal instruments to encourage conservation: municipal responses to the 'ecological' value-added tax in Parana and Minas Gerais, Brazil, in: Pagiola, S., Bishop, J. and Landel-Mills, N. (Eds.), *Selling Forest Environmental Services*. Earthscan Publications Limited, London; Sterling, VA, pp. 173-99.
- Max-Neef, M., 2005. Foundations of transdisciplinarity. *Ecological Economics*, 53: 5-16.
- Max-Neef, M., 1993. *Human Scale Development: Conception, Application, and Further Reflections*. Apex Press, London.
- McDade, L., Bawa, K.S., Hespenheide, H., Hartshorn, G. (eds.), 1994. *La Selva: Ecology and Natural History of a Neotropical Rain Forest*. University of Chicago Press, Chicago.
- Millennium Ecosystem Assessment. 2005. *Ecosystems and Human Well-being: Synthesis*. Washington, DC: Island Press.

Milner, H., 2002. *Civic Literacy: How Informed Citizens Make Democracy Work*. University Press of New England, Hanover, NH.

Miranda, M., Dieperink, C., Glasbergen, P. 2006. Costa Rican environmental service payments: the use of a financial instrument in participatory forest management. *Environmental Management* 38, 562-571.

Miranda, M., Porras, I.T. and Moreno, M.L., 2003. The Social Impacts of Payments for Environmental Services in Costa Rica: A Quantitative Field Survey and Analysis of the Virilla Watershed. International Institute for Environment and Development, London.

Morse, J. and Richards, L. *Readme First for a User's Guide to Qualitative Methods*. Thousand Oaks: SAGE Publications, 2002.

Mulder, M., Coppolillo, P. 2005. *Conservation: Linking Ecology, Economics and Culture*. Princeton University Press, Princeton, NJ.

Müller, A., 2003. A flower in full blossom? Ecological Economics at the crossroads between Normal and Post-normal Science. *Ecological Economics*. 45, 19-27.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J., 2000. Biodiversity hotspots for conservation priorities. *Nature*. 403(6772), 853-859.

Naidoo, R., Ricketts, T.H., 2006. Mapping the economic costs and benefits of conservation. *PLOS Biology*, 4 (11): 2153-2164.

National Statistics, UK. 2003. *Social Capital*. Available at: <http://www.statistics.gov.uk/socialcapital/>, accessed on November 10, 2006.

Neumann, R., & Becher, T. (2002). Teaching and learning in their disciplinary contexts: A conceptual analysis. *Studies in Higher Education*, 27(4), 405–417.

Neupane, R. P., Sharma, K. R., Thapa, G. B., 2002. Adoption of agroforestry in the hills of Nepal: a logistic regression analysis. *Agricultural Systems* 72, 177-196.

Nicolescu, B., 2005. Towards transdisciplinary education and learning, Conference Proceedings for Science and Religion: Global Perspectives Conference, held in Philadelphia, PA, USA, June 4-8, 2005.

Nicolescu, B., 2002a. Manifesto of Transdisciplinarity. State University of New York Press, Albany.

Niculescu, B., 2002b. Levels of reality and the sacred, Foundations and the Ontological Quest: Prospects for the New Millennium, Pontifica Universitas Lateranensis, Vatican.

Niculescu, B., 1997. The transdisciplinary evolution of the university condition for sustainable development, International Congress "Universities' Responsibilities to Society". International Association of Universities, Chulalongkorn University, Bangkok, Thailand.

Niemi, R. and Junn, J., 1999. *Civic Education: What Makes Students Learn?* Yale University Press, New Haven, CT.

Northwestern Institute on Complex Systems (NICO). 2007. About Complex Systems."from http://www.northwestern.edu/nico/complex_systems/index.html, accessed on September 10, 2008.

O'Grady, M.A. 2006. Costa Rican poverty fighter. The Wall Street Journal. May 5, 2006.

Olson, M., 1965. *The Logic of Collective Action*. Harvard University Press, Cambridge, MA.

Ormrod, J. E. 1999. *Human Learning*. Upper Saddle River, NJ, Prentice-Hall.

Orr, D. 2004. *Earth in Mind*. Washington, DC: Island Press.

Ortiz Malavasi, E., Sage Mora, L.F., Borge Cavajal, C., 2003. Impacto del programa de pago de servicios ambientales en Costa Rica como medio de reducción de la pobreza en los medios rurales, Unidad Regional de Asistencia Técnica (RUTA), San José, Costa Rica.

Oviedo, E., 2006. Estado paga poco por conservar bosques. La Nacion, 20 de noviembre.

Özakynak, B., Devine, P. and Rigby, D., 2004. Operationalising Strong Sustainability: Definitions, Methodologies and Outcomes. *Environmental Values*, 13(3): 279-303.

Pagiola, S., 2006. Payments for environmental services in Costa Rica. MPRA Paper No. 2010. Revised version of a paper presented at the ZEF-CIFOR workshop on Payments for environmental services: Methods and design in developing and developed countries, Titisee, Germany, July 15-18, 2005.

Pagiola, S., Arcenas, A., Platais, G., 2005a. Can payments for environmental services help reduce poverty? An exploration of the issues and the evidence to date from Latin America. *World Development* 33, 237-253.

Pagiola, S., Agostini, P., Gobbi, J., de Haan, C., Ibrahim, M., Murgueitio, E., Ramirez, E., Rosales, M., Ruiz, J. P., 2005b. Paying for biodiversity conservation services - Experience in Colombia, Costa Rica, and Nicaragua. *Mountain Research and Development* 25, 206-211.

Pagiola, S., 2002. Paying for water services in Central America: learning from Costa Rica, in: Pagiola, S., Bishop, J. and Landel-Mills, N. (Eds.), *Selling Forest Environmental Services: Market-based Mechanisms for Conservation and Development*. Lndon; Sterling, VA:Earthscan Publications, Limited.

Parkinson, S.a.R., R., 2006. Using a sustainable livelihoods approach to assessing the impact of ICTs in development. *The Journal of Community Informatics*, 2(3).

Partnership for 21st Century Skills, 2004. "Definition of Terms," available at: http://www.21stcenturyskills.org/index.php?option=com_content&task=view&id=258&Itemid=126, accessed on May 10, 2008.

Patton, M.Q., 2002. *Qualitative Research and Evaluation Methods*. Sage Publications, Thousand Oaks, CA.

Pickett, S.T.A., Burch, W.R., Grove, J.M., 1999. Interdisciplinary research: maintaining the constructive impulse in a culture of criticism. *Ecosystems*, 2: 302-307.

PlusPetrol, 2004. Compensation Program for the Native Communities of Block 88, PlusPetrol Peru Corporation.

Polasky, S., Camm, J.D., Garber-Yonts, B., 2001. Selecting biological reserves cost-effectively: An application to terrestrial vertebrate conservation in Oregon. *Land Economics*, 77 (1): 68-78.

Pribbenow, D.A., 2005. The impact of service-learning pedagogy on faculty teaching and learning. *Michigan Journal of Community Service Learning*, 11(2): 25-38.

The President's Council on Sustainable Development. (PCSD) 1999. *Towards A Sustainable America: Advancing Prosperity, Opportunity and a Healthy Environment for the 21st Century*. Available at: <http://clinton2.nara.gov/PCSD/Publications/tsa.pdf>, accessed June 2007.

Putnam, R.D. 2000. *Bowling Alone: The Collapse and Revival of American Community*. New York, New York: Simon & Schuster.

Ragin, C.C. and Becker, H.S. (eds.) 1992. *What Is a Case? Exploring the Foundations of Social Inquiry*. Cambridge: Cambridge University Press.

Ramsar, Secretariat Convention, 2005. Resolution IX.1 Annex E: On rapid assessment of wetland biodiversity.

Randall, A., 1993. The Problem of Market Failure. In: Economics of the Environment. R. Dorfman and N. Dorfman, eds. Norton, New York.

Reij, C., Scones, I. and Toulmin, C. 1996. *Sustaining the Soil: Indigenous Soil and Water Conservation in Africa*. London: Earthscan.

Richmond, B. 2005. "Systems thinking and the *STELLA* Software: Thinking, communicating, learning and acting more effectively in the new millennium," in *An Introduction to Systems Thinking, STELLA*. Cleveland, Ohio: International Society for Ecological Economics.

Rodriguez, J. P., Beard, T. D., Bennett, E. M., Cumming, G. S., Cork, S. J., Agard, J., Dobson, A. P., Peterson, G. D., 2006. Trade-offs across space, time, and ecosystem services. *Ecology and Society* 11, 28.

Rojas, M., Aylward, B., 2003. What are we learning from experiences with markets for environmental services in Costa Rica? A review and critique of the literature. International Institute for Environment and Development, London.

Salzman, J., Ruhl, J.B., 2002. Paying to protect watershed services: Wetland banking in the United States. In: Pagiola, S. and Bishop, J. (eds). *Selling Forest Ecosystem Services: Market-based mechanisms for conservation and development*. Earthscan, London.

Salzman, J., 2005. Creating markets for ecosystem services: Notes from the field. *New York University Law Review*, 80 N.Y.U.L. Rev. 870.

Samuelson, P.A., 1954. The pure theory of public expenditure. *The review of Economics and Statistics* 36 (4): 387-389.

Sanchez-Azofeifa, G., Harriss, R. C., Skole, D. L., 2001. Deforestation in Costa Rica: A quantitative analysis using remote sensing imagery. *Biotropica* 33, 378-384.

Sanchez-Azofeifa, G. A., Daily, G. C., Pfaff, A. S. P., Busch, C., 2003. Integrity and isolation of costa rica's national parks and biological reserves: Examining the dynamics of land-cover change. *Biological Conservation* 109, 123-135.

Sanders, S. R. (1998). Hunting for Hope. Boton, Beacon Press

Sayer, J.A., 1995. *Science and International Nature Conservation*. Center for International Forestry Research, Bogor, India.

- Schlosser, J.A., Garner, T.W.J., Dubach, J.M., McElligott, A.G., 2003. Characterization of microsatellite loci in Humboldt penguin (*Spheniscus humboldti*) and cross-amplification in other penguin species. *Molecular Ecology Notes*. 3(1), 62-64.
- Segura, O., 1992. Los incentivos forestales en Costa Rica: Politicas economicas del sector, No5. Universidad Nacional, Heredia, Costa Rica.
- Sen, A.K., 1992. *Inequality Reexamined*. Harvard University Press, Cambridge, MA.
- Senge, P. 1990. *The Fifth Discipline*. New York, New York: Doubleday.
- Sierra, R., Russman, E., 2006. On the efficiency of environmental service payments: A forest conservation assessment in the Osa Peninsula, Costa Rica. *Ecological Economics* 59 (1): 131-141.
- Sills, E., Hartshorn, G., Ferraro, P., and Spergel, B. 2005. Evaluation of the World Bank-GEF ecomarkets project in Costa Rica. Blue Ribbon Panel Report. North Carolina State University, Durham, North Carolina.
- Simpson, B.S. 1999. *The Roots of Change: Human Behaviour and Agricultural Evolution in Mali*. London: Intermediate Technology Publications.
- Smith, A. 1759. *The Theory of Moral Sentiments*. London: A. Millar.
- Smithsonian, 2007. Monitoring and Assessment of Biodiversity.
- Söderbaum, P., 1999. Values, ideology and politics in ecological economics. *Ecological Economics*, 28:161-170.
- Spence, D.B., 2001. The shadow of the rational polluter: rethinking the role of rational actor models in environmental law. *California Law Review* 1-57.
- Stake, R.E. 1995. *The Art of Case Study Research*. Thousand Oaks, CA: Sage Publications.
- Stake, R.E. 1995. *The Art of Case Study Research*. Thousand Oaks: Sage Publications.
- Steed, B, 2003. Completing the mosaic: the conservation of private lands in Costa Rica. *Journal of Land, Resources, and Environmental Law* 173, 173-180.
- Stern, P. C. (2000). Toward a coherent theory of environmentally significant behavior." *Journal of Social Issues* 56(3), 407-424.
- Stiglitz, J. 2006. *Making Globalization Work*. New York, NY: Norton & Company.
- Stiglitz, J. 2002. *Globalization and Its Discontents*. New York, NY: Norton & Company

Stoms, D.M., Chomitz, K.M., Davis, F.W., 2004. TAMARIN: a landscape framework for evaluating economic incentives for rainforest restoration. *Landscape and Urban Planning*, 68: 95-108.

Stoneham, G., Chaudri, V., Ha, A., Strappazon, L., 2003. Auctions for conservation contracts: An empirical examination of Victoria's BushTender trial. *Australian Journal of Agricultural and Resource Economics*, 47 (4), 477-500.

Straton, A. 2006. A complex systems approach to the value of ecological resources. *Ecological Economics*. 56, 402-411.

Szentandrasi, S., Polasky, S., Berrens, R., Leonard, J. 1995. Conserving biological diversity and the conservation reserve program. *Growth and Change*, 26: 383-404.

Tacconi, L., 1998. Scientific methodology for ecological economics. *Ecological Economics*, 27, 91-105.

Thomashow, M. 2002. *Bringing the Biosphere Home: Learning to Perceive Global Environmental Change*. Cambridge, MA, MIT Press.

Tietenberg, T.H., 1989. Economic instruments for environmental regulation. *Oxford Review of Economic Policy*, 6 (1): 17-33.

Tirado, C.S., 2006. Evaluation of Camisea Project Piping Failures and Long-Term Solutions, E-Tech International.

Tomer, J.F. and Sadler, T.R., 2007. Why we need a commitment approach to environmental policy. *Ecological Economics*, 62: 627-636.

Turner, M.G. and Carpenter, S.R., 1999. Tips and traps in interdisciplinary research. *Ecosystems*, 2: 275-276.

Turner, R.K., Paavola, J., Cooper, P., Farber, S., Jessamy, V., Georgiou, S. 2003. Valuing nature: Lessons learned and future research directions. *Ecological Economics*. 46, 493-510.

United Nations. 1987. Report of the World Commission on Environment and Development. General Assembly Resolution 42/187.

United States Agency of International Development (USAID), 2004. Multilateral development bank assistance proposals: likely to have adverse impacts on the environment, natural resources, public health and indigenous people.

Vasquez, V., 2000. Our way: Using the everyday to create a critical literacy curriculum. *Primary Voices*, 9(2): 8-13.

Wallack, L. Woodruff, K. Dorfman, L. and Diaz, I. 1999. *News for a Change: An Advocate's Guide to Working With the Media*. Thousand Oaks, CA: Sage Publications.

Watson, V., Cervantes, S., Castro, C., Mora, L., Solis, M., Porras, I.T., Cornejo, B., 1998. Making space for better forestry: Costa Rica country study. *Policy that Works for Forests and People Series* No: 6. International Institute for Environment and Development: London.

Weisskirch, R.S., 2003. Analyzing student journals in a service-learning course. *Academic Exchange Quarterly*, 7(2): 141-146.

World Bank, 2000. Costa Rica Ecomarkets Project. Project Appraisal. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

World Bank. 2000. Costa Rica: Forest strategy and the evolution of land use. Operations Evaluation Department, World Bank, Washington, DC.

World Bank, 2006. Scaling up and mainstreaming payment for environmental services in Costa Rica. Project Appraisal. Environmentally and Socially Sustainable Development, Latin America and the Caribbean Regional Office.

World Bank. 2007. Key Development Data & Statistics. Available at <http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/>, accessed May 2, 2007.

Wunder, S., 2007. The efficiency of payments for environmental services in tropical conservation. *Conservation Biology*, 21(1): 48-58.

Wunder, S., 2005. Payments for environmental services: Some nuts and bolts. CIFOR Occasional Paper No. 42. Center for International Forestry Research, Jakarta, Indonesia
Yin, R.K. 2002. *Case Study Research: Design and Methods*. (3rd Edition). Applied Social Research Methods Series 5. Thousand Oaks, CA: Sage Publications

Wünscher, T., Engel, S., Wunder, S., 2007. Spatial targeting of payments for environmental services: A tool for boosting conservation benefits. Presented at the Workshop on Carbon Sequestration in Agriculture and Forestry conference, Thessaloniki, Greece, June 27, 2007.

Zbinden S., and Lee, D.R., 2005. Paying for environmental services: An analysis of participation in Costa Rica's PSA program. *World Development*, 33 (2): 255-272.

Zilberman, D., Lipper, L., McCarthy, N., 2006. Putting payments for environmental services in the context of economic development, The Food and Agriculture Organization.